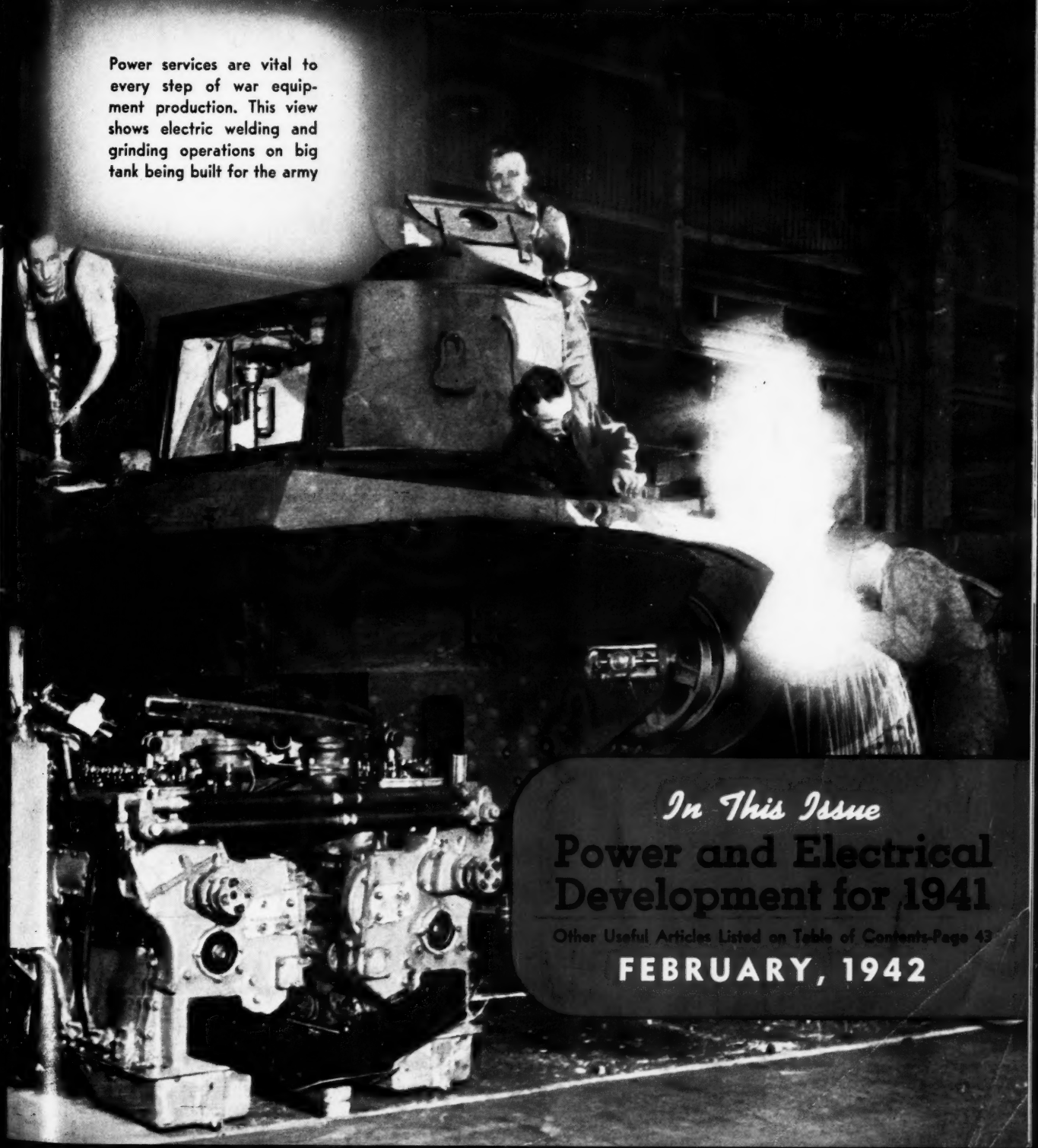
POWER PLANT ENGINEERING

THE PLANT ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY



Power services are vital to every step of war equipment production. This view shows electric welding and grinding operations on big tank being built for the army

In This Issue

Power and Electrical Development for 1941

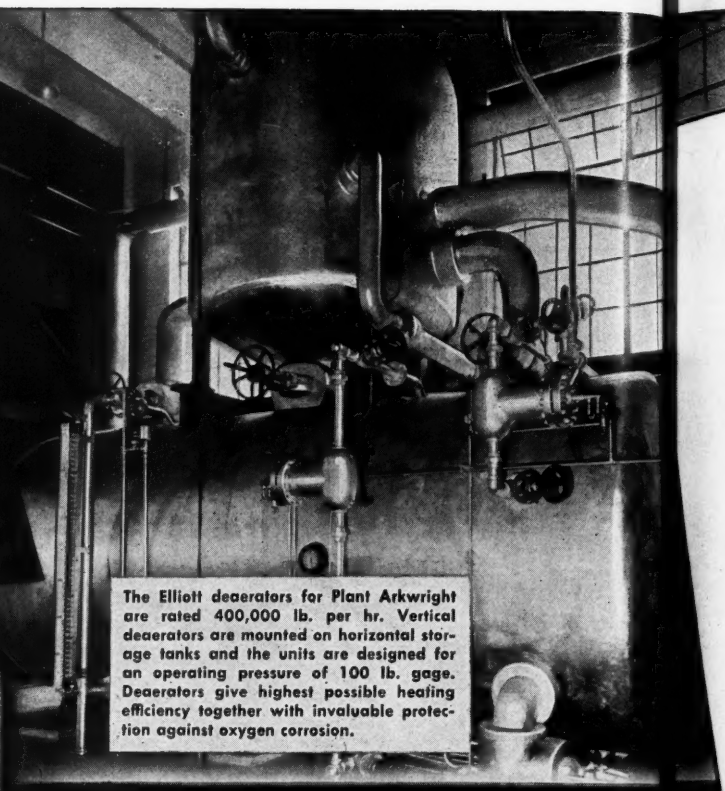
Other Useful Articles Listed on Table of Contents-Page 43

FEBRUARY, 1942

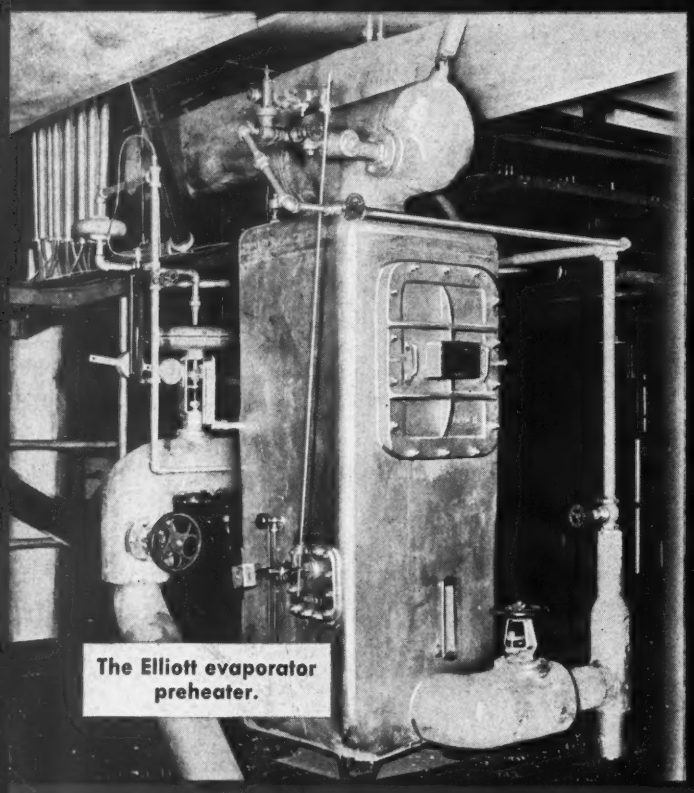
Dependable STEAM P

ELLIOTT

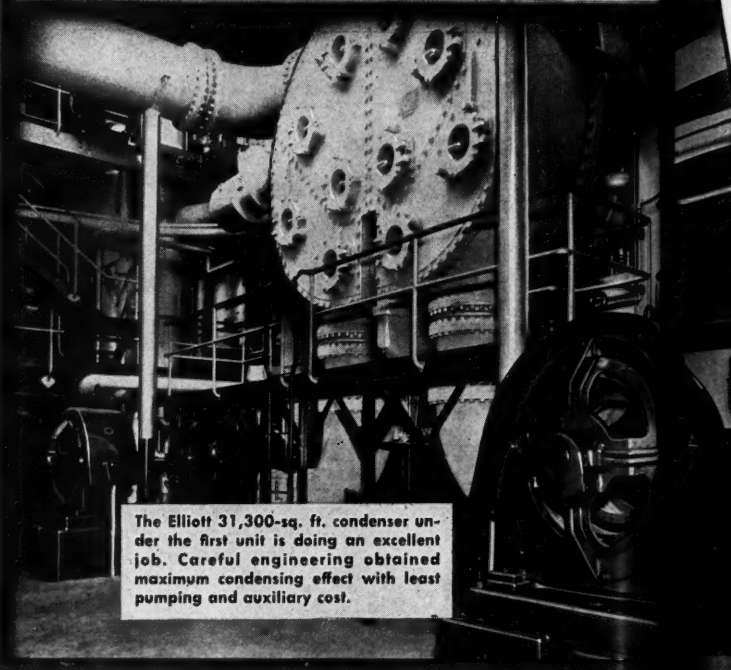
Condensers, Deaerators, and other equipment help Georgia Power Company to meet southern power shortage.



The Elliott deaerators for Plant Arkwright are rated 400,000 lb. per hr. Vertical deaerators are mounted on horizontal storage tanks and the units are designed for an operating pressure of 100 lb. gage. Deaerators give highest possible heating efficiency together with invaluable protection against oxygen corrosion.



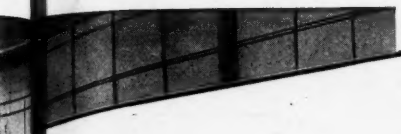
The Elliott evaporator preheater.



The Elliott 31,300-sq. ft. condenser under the first unit is doing an excellent job. Careful engineering obtained maximum condensing effect with least pumping and auxiliary cost.

ELLIOTT

POWER *to the rescue!*



POWER SHORTAGE IN THE SOUTH

throws the spotlight on the new outstanding station of the Georgia Power Company, Plant Arkwright. Hardly had this station been planned before its original capacity was doubled, and then trebled. In order to get power as quickly as possible for industries vital in National Defense, the station was built and the first 40,000-kw. unit put into steady operation in remarkably short time, at full rated capacity.

Elliott condensers and deaerators are important parts of the equipment of this outstanding station, and Elliott Company is glad to have assisted in speeding the station into operation, by making deliveries on time, and rushing the erection of its equipment.

The photographs show installations of the first Elliott condenser and deaerator. Similar equipment for the second 40,000-kw. unit is on the job, while a third condenser and deaerator are being hurried on their way to completion.

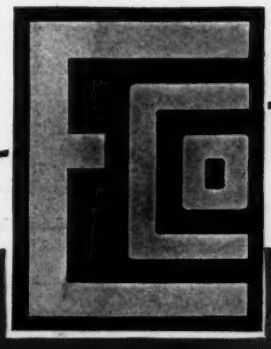
The Elliott condensers are 31,300-sq. ft. two pass, divided water-box units with all-welded steel shells, served by Elliott twin two-stage steam jet ejectors and auxiliary equipment. The first condenser is operating continuously under rather large overload with very good performance.

The Elliott deaerators for the station are of A.S.M.E. Code Class 1 welded construction, designed for an operating pressure of 100 lb. gage. They act as the No. 3 heater in a four-stage extraction heating cycle. Thus "zero" oxygen deaeration is obtained along with feed heating at incidental cost. The vertical deaerator is mounted on a large horizontal storage tank which acts as the surge tank for the system and provides for feedwater additions or rejection.

An Elliott 12,000-lb.-per-hr. evaporator preheater deaerates make-up water before it enters the evaporator.

Q-1081

Elliott condensers and deaerators are built in a complete range of sizes for plants large or small, and our engineers are glad to co-operate with you in selecting the right type and size equipment to fit into your heat balance requirements.



COMPANY

JEANNETTE, PA., RIDGWAY, PA.
SPRINGFIELD, OHIO

District Offices in Principal Cities

PRODUCERS OF TURBINE-GENERATORS • MECHANICAL DRIVE TURBINES • ENGINES • DIESEL-GENERATORS
ROTOR-GRINDING SERVICE • BLOWERS • GENERATORS • CONDENSERS • STEAM JET EJECTORS • DEAERATORS
FEED-WATER HEATERS • SURFACE HEATERS • CENTRIFUGAL BLOWERS • TURBO-CHARGERS • DESUPERHEATERS
STRAINERS • SEPARATORS • GREASE EXTRACTORS • NON-RETURN VALVES • LABYRINTH PACKING TUBE CLEANERS

"ALL-OUT" Aid to B
the BATTLE OF P

Bailey Meter Control Insures Ful
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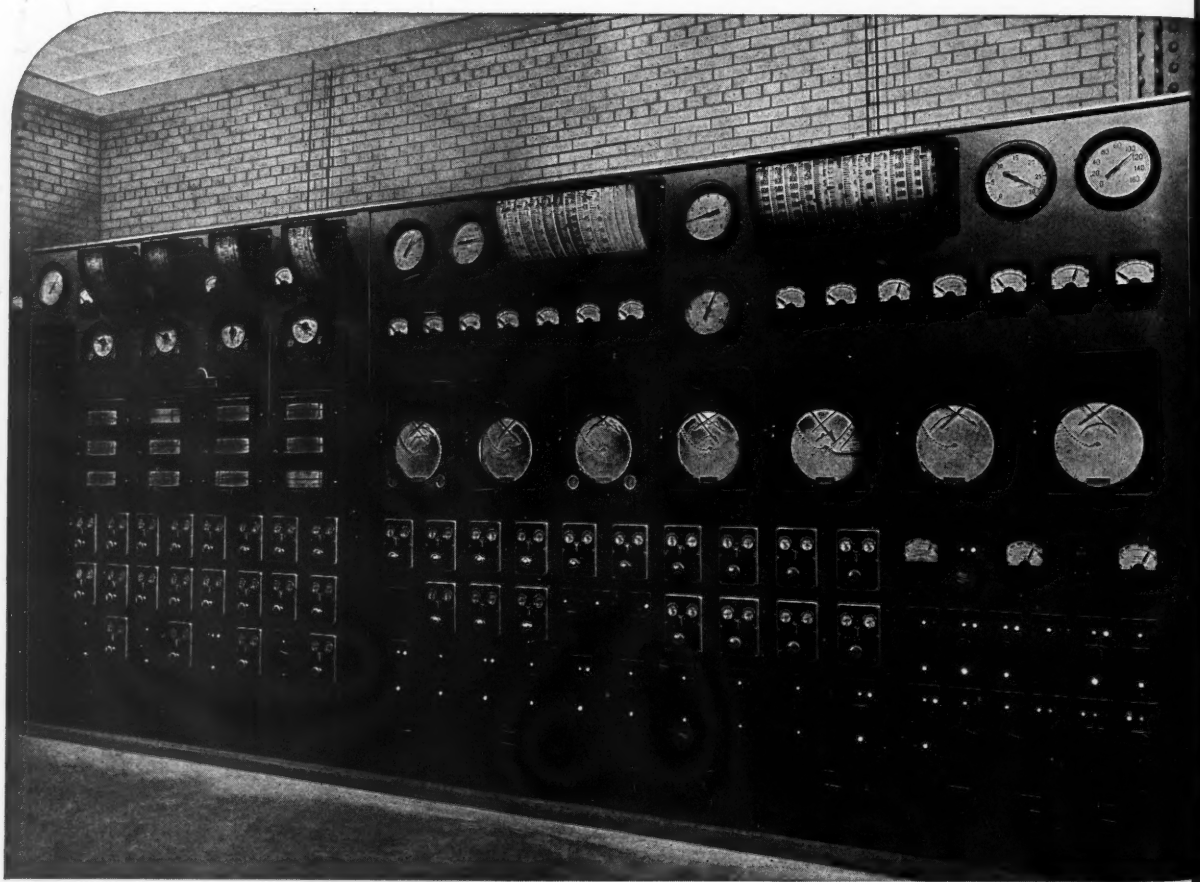

Bailey Boiler Control Panel for Combustion and Three-element Feed Water Control Systems serving a 900,000 lb. per hour capacity boiler at the Oswego Station of Central New York Power Corporation

BAILEY METER CONTROL

BOILER METERS • MULTI-POINTER GAGES • FLUID METERS • RECORDERS • SUPERHEA

The
ONTR

Publ
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Boilers in PRODUCTION

Full Steaming Capacity and Man Power ★ ★ ★

★ Bailey Meter Control is helping to win the battle of production by giving "All-Out" aid to hard pressed steam generating equipment. Here at the very source of power, Bailey Meter Control serves faithfully day after day to continuously maintain the most favorable operating conditions. Conditions which mean full capacity, reliable service, safe operation, economical use of fuel, and conservation of man power.

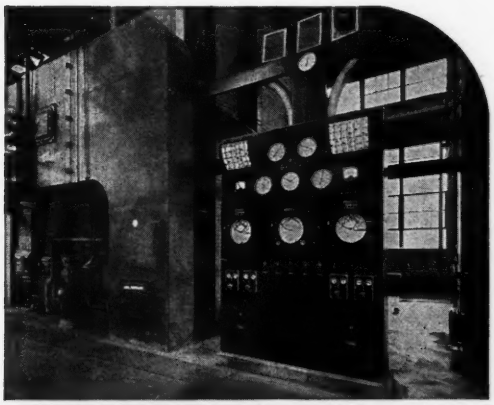
In addition to serving in the battle of production, Bailey Meter Control is "with the colors" at Air bases, Army training camps, Naval bases, Arsenals, Forts, and other establishments of our armed services. It is also serving at sea with America's fast-growing Merchant Marine.

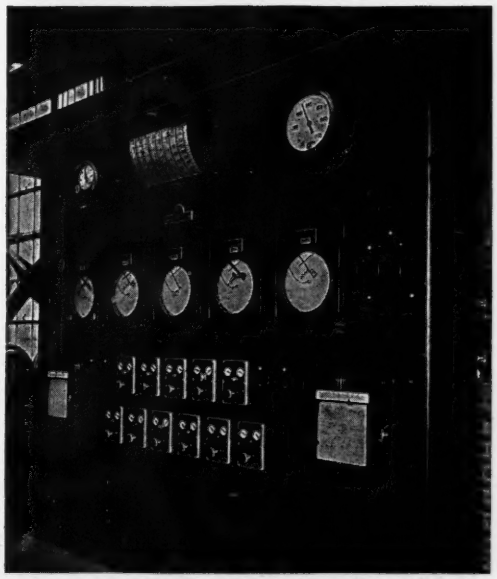
Bailey Meters and Control are now helping to speed National Defense by the same fundamental methods of boiler control which in the past have made available generous supplies of low cost steam power. A-77

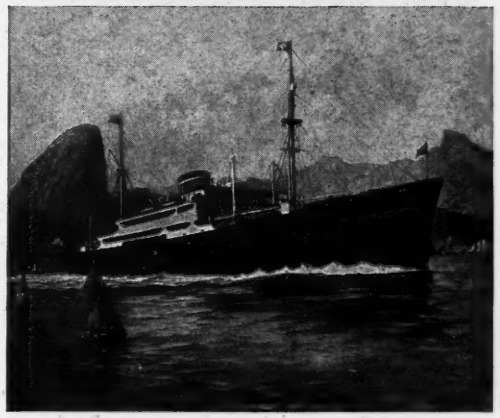
BAILEY METER COMPANY

1036 IVANHOE ROAD • CLEVELAND, OHIO

Bailey Meter Company Limited, Montreal, Canada







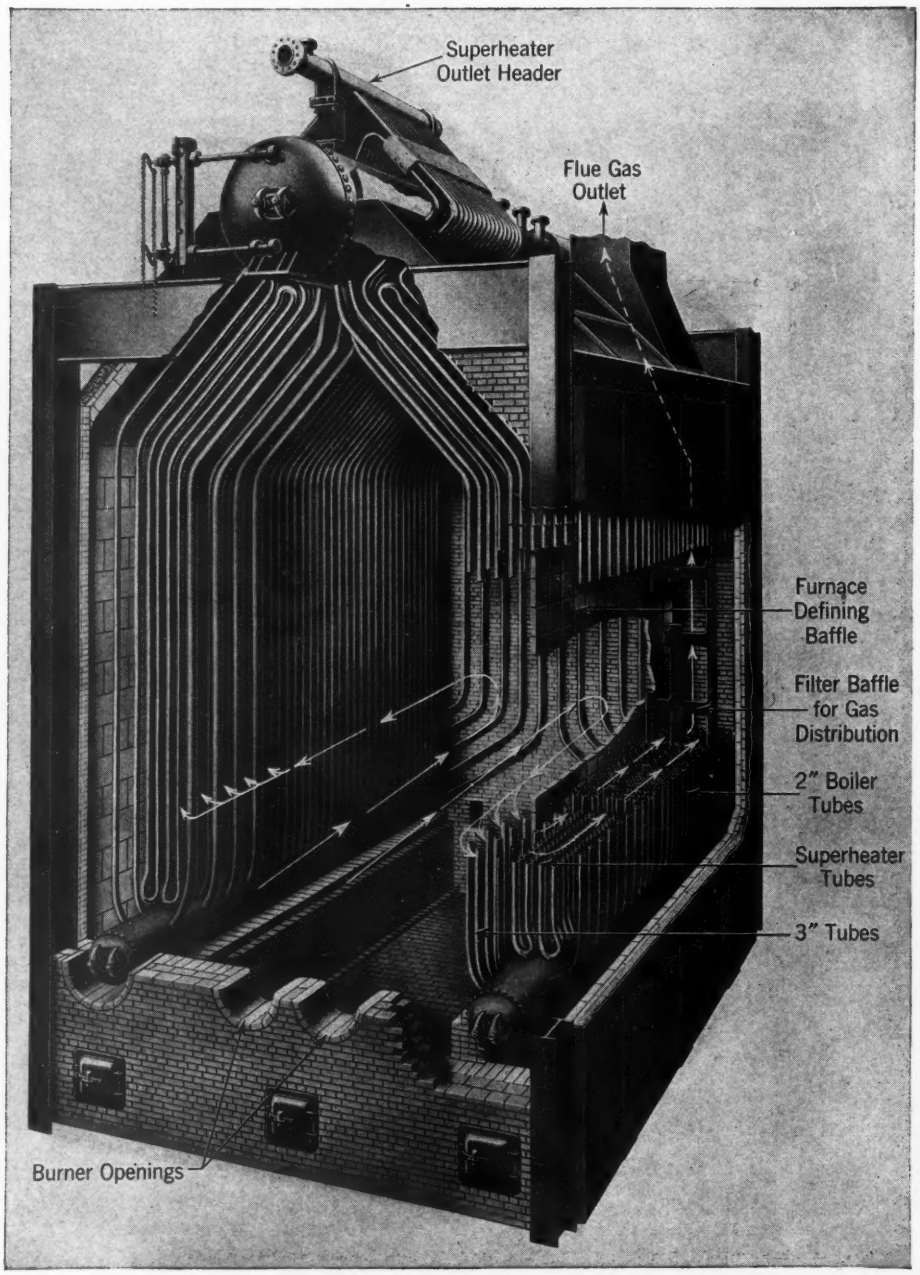
Bailey Meter Control is installed in many industries vital to our defense. Three of these are—(Top) A Plastic and Chemical Plant, (Center) A large Steel Plant, and (Bottom) The Merchant Marine.

The Complete Combustion Control System

ONTROL • DESUPERHEAT CONTROL • COMBUSTION CONTROL • FEED WATER CONTROL

Published monthly by the Technical Publishing Co., at 53 West Jackson Blvd., Chicago, Ill., U. S. A. Subscription price, $2.00 a year. Single copies current issue, 25c. Entered as second class matter September 8, 1932, at the Post Office, Chicago, Ill., under act of March 3, 1879. Vol. XLVI, No. 2.

"S-A" BOILER



Perspective drawing of an "S-A" steam generator showing construction details of a reverse-fired unit. This drawing is scaled from an actual installation for 75,000 lb. steam per hour.

FW FOSTER

ADVANTAGES

DESIGN RANGE

Capacity—7000 lb. per hr. to 218,000 lb. per hr.

Pressure—125 lb. to 650 lb. per sq. inch

Final Steam Temp.—438° F. to 850° F.

FUELS

Coal: Hand fired, Stoker fired, Pulverized;
Oil; Gas; Bark Refuse; By-product Tar

OPERATING

1. *Boiler surrounds furnace*

   More boiler tubes are exposed to furnace than with two-drum arrangement

   As sides of boiler are encased, the amount of brickwork required is reduced

2. *High Efficiency*

   Cross flow of gases

   Staggered tube arrangement

3. *Low draft loss*

   Due to one straight pass of gas through boiler

4. *Methods of firing*

   From front with gases entering boiler at rear

   From front with gases passing to rear, reversing, and entering boiler at front, giving unusually long flame travel

   From both ends simultaneously, using different fuels

REPRESENTATIVE USERS*

Canadian Industries Ltd.
Cia Textilera Ariguanabo
British American Oil Company Ltd.
Canadian Furnace Ltd.
Ontario Paper Company
Shell Oil Company
The Texas Company
Westinghouse International Company
Kansas Electric Power Company
Socony-Vacuum Oil Company
City of Holyoke Gas & Electric Company
Chemical Construction Company

* These companies operate a total of 33 "S-A" units—including 9 repeat orders.

Foster Wheeler Corporation, 165 Broadway, New York, N. Y.

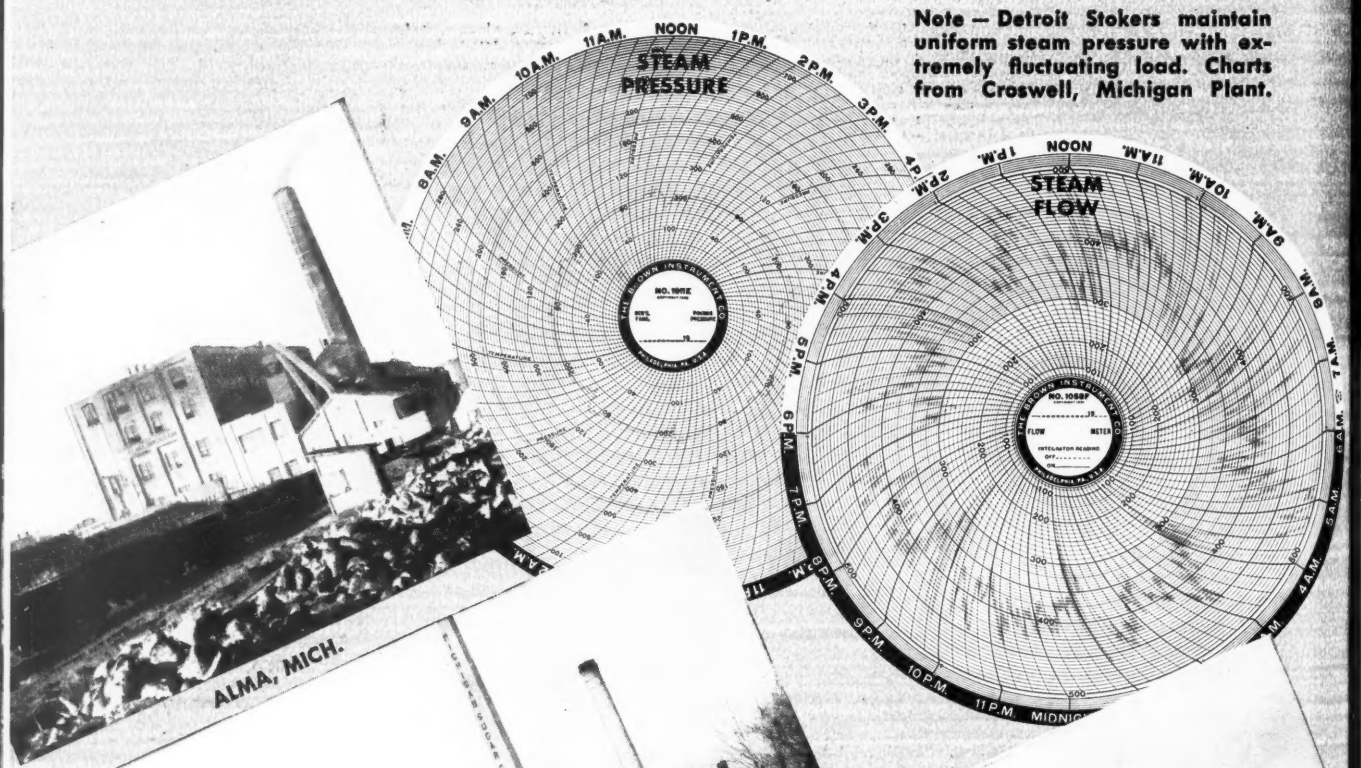
WHEELER

DETROIT STOKERS

DO A SWEET JOB FOR MICHIGAN SUGAR COMPANY

Dependable Steam Supply is of paramount importance in the production of fine sugar from sugar beets. Heavy steam loads—Twenty-four hours a day. Steam Generating equipment must not fail.

MICHIGAN SUGAR COMPANY uses nineteen DETROIT STOKERS —Total capacity over 800,000 pounds of steam per hour, IN SIX PLANTS.



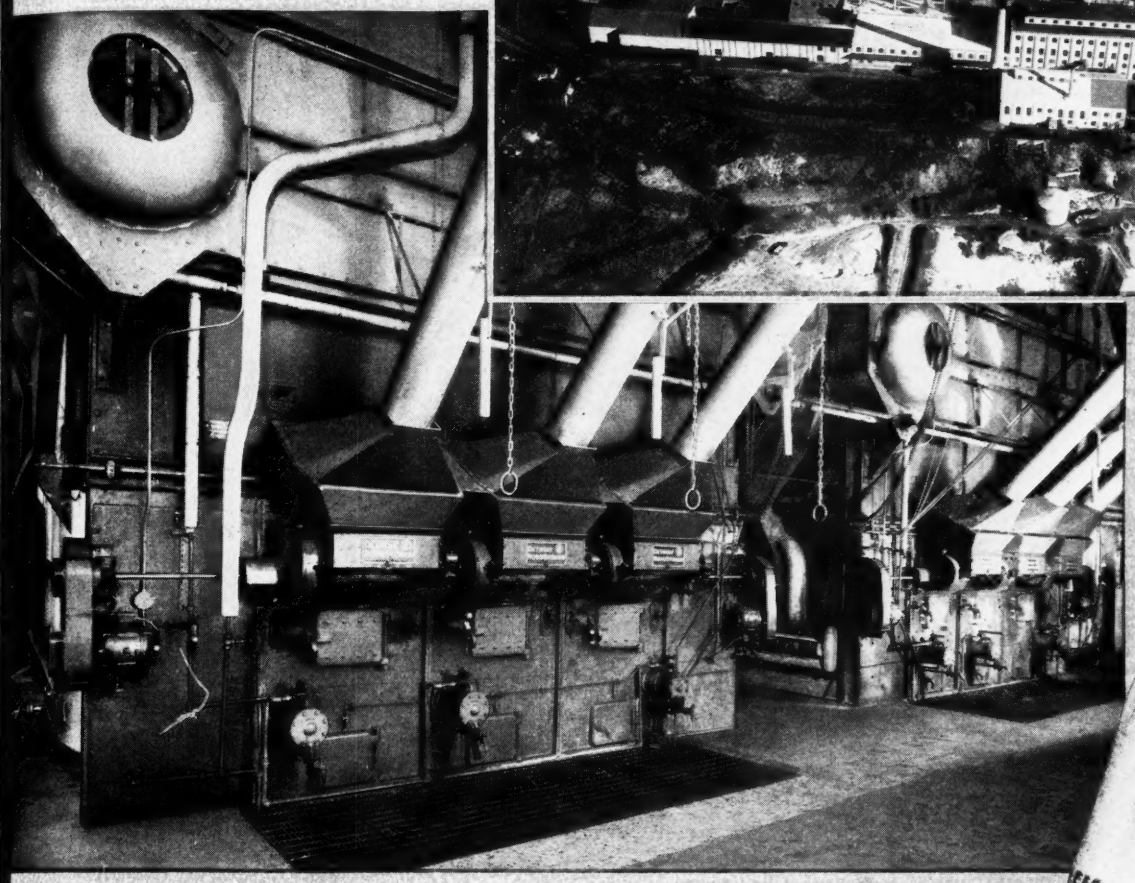
Note — Detroit Stokers maintain uniform steam pressure with extremely fluctuating load. Charts from Croswell, Michigan Plant.

ALMA, MICH.

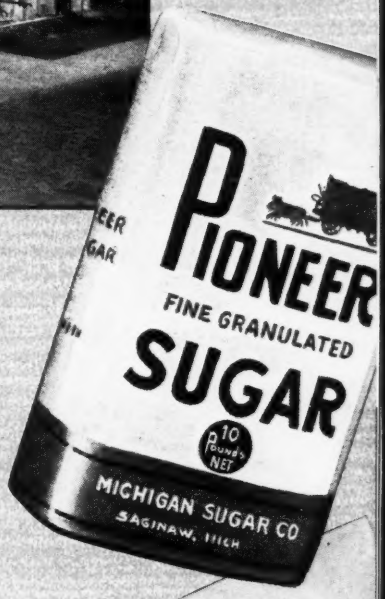
SAGINAW, MICH.

CROSWELL, MICH.

LANSING, MICH.



Detroit Stokers at Lansing, Mich. Total 160,000 pounds of steam per hour.

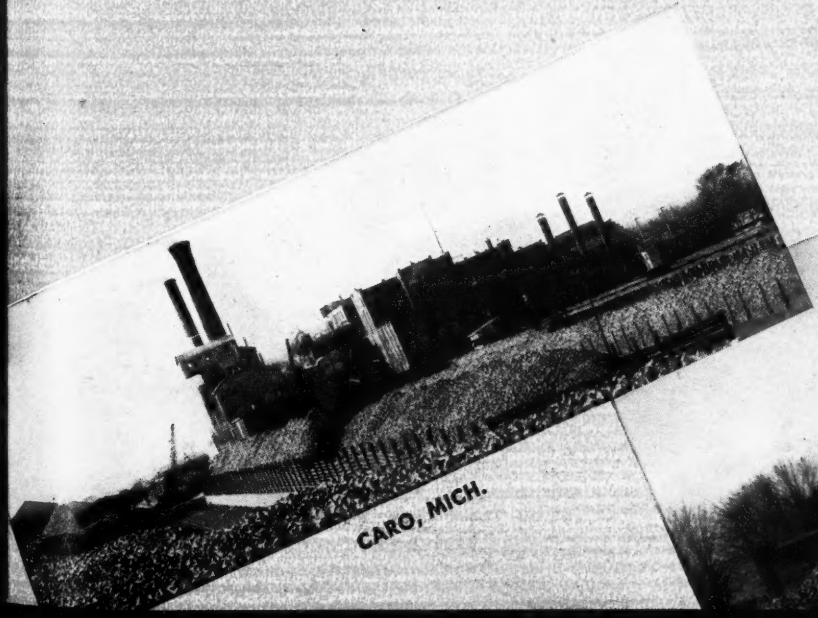


SEND FOR BULLETIN 524

DETROIT STOKER COMPANY

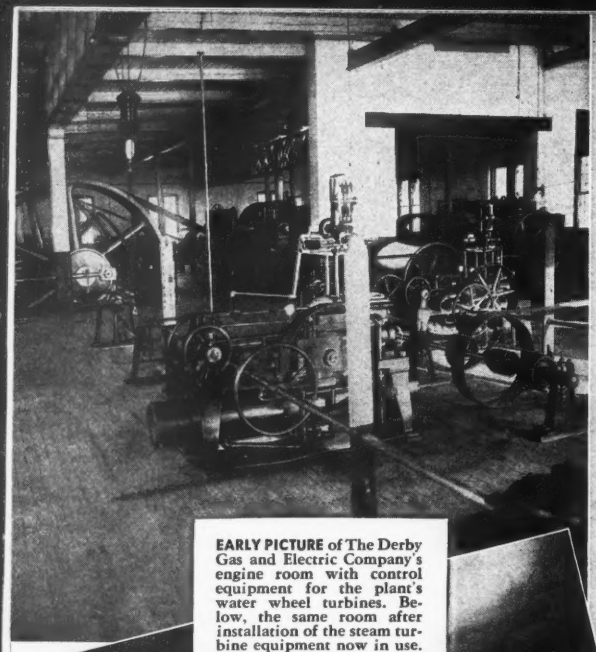
Sales and Engineering Offices,
General Motors Bldg., Detroit

Main Office and Works, Monroe, Mich.
Built in Canada at London, Ontario

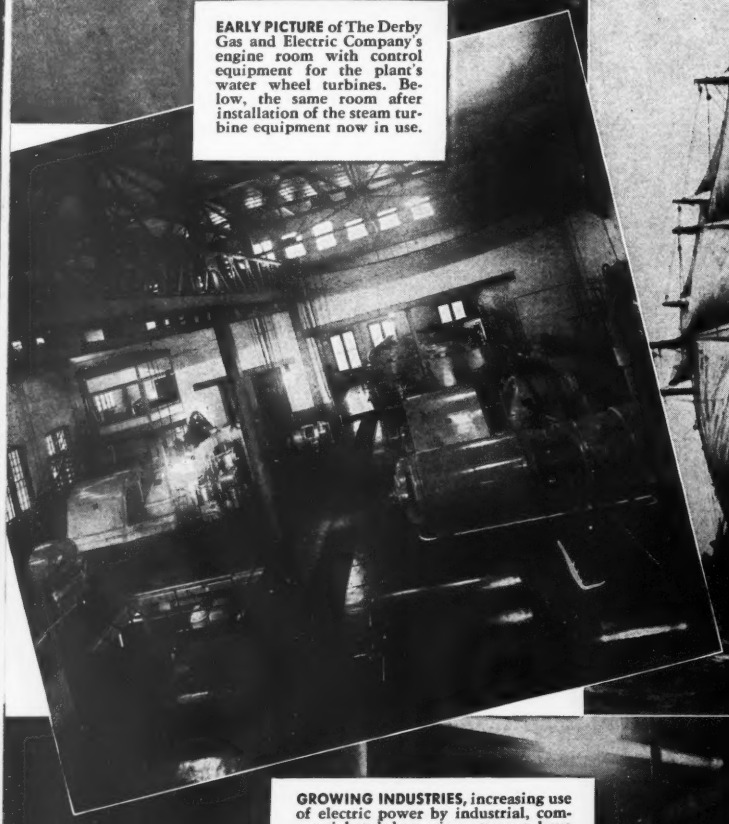


CARO, MICH.

SEBEWAING, MICH.

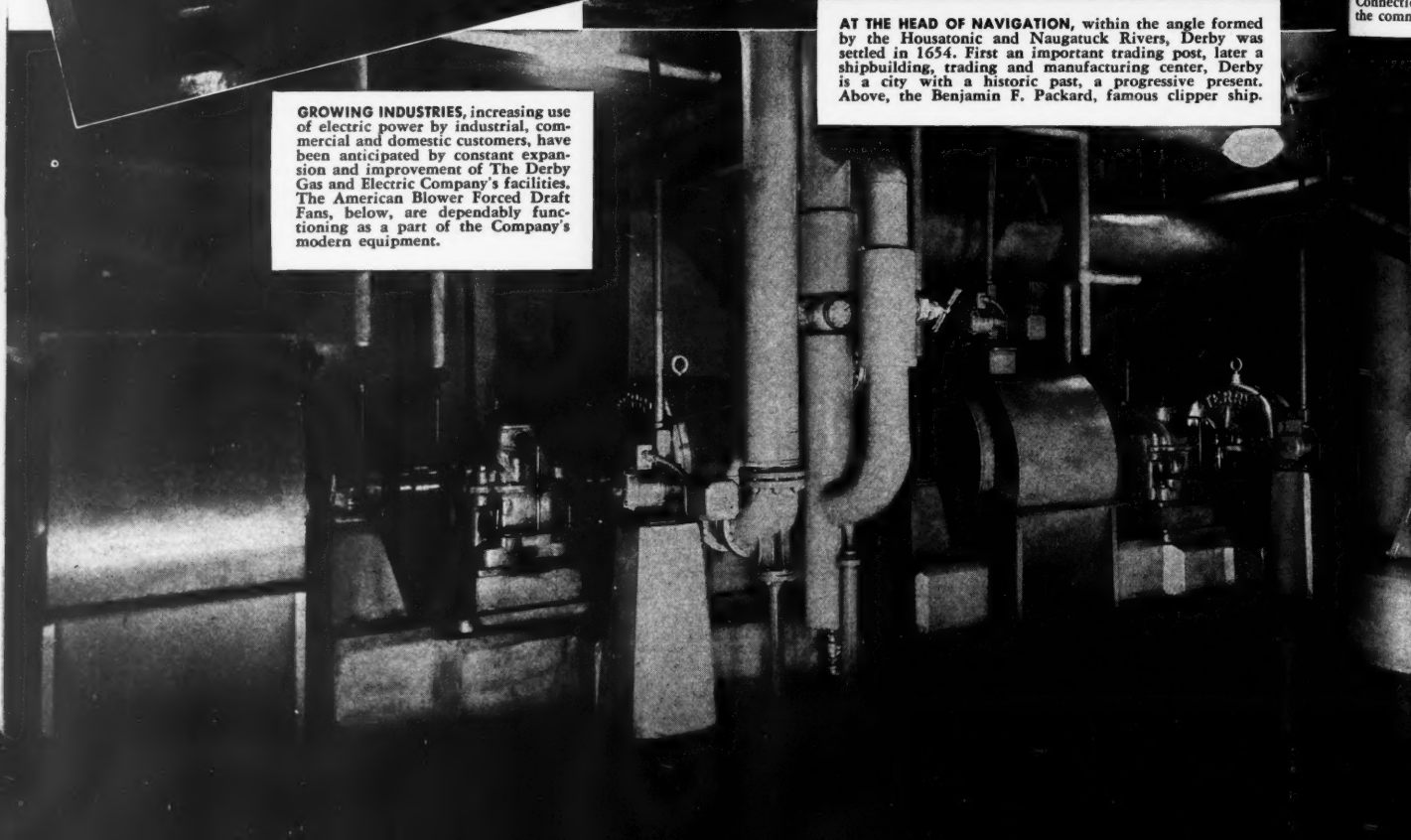


EARLY PICTURE of The Derby Gas and Electric Company's engine room with control equipment for the plant's water wheel turbines. Below, the same room after installation of the steam turbine equipment now in use.



AT THE HEAD OF NAVIGATION, within the angle formed by the Housatonic and Naugatuck Rivers, Derby was settled in 1654. First an important trading post, later a shipbuilding, trading and manufacturing center, Derby is a city with a historic past, a progressive present. Above, the Benjamin F. Packard, famous clipper ship.

GROWING INDUSTRIES, increasing use of electric power by industrial, commercial and domestic customers, have been anticipated by constant expansion and improvement of The Derby Gas and Electric Company's facilities. The American Blower Forced Draft Fans, below, are dependably functioning as a part of the Company's modern equipment.



THE DERB
The Com
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Smooth Sailing

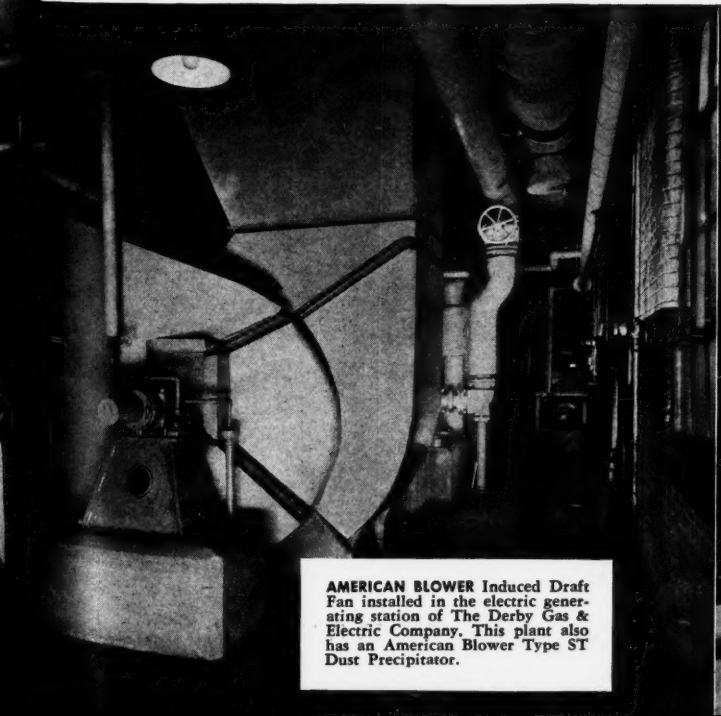
at Derby, Connecticut!

THE DERBY GAS AND ELECTRIC COMPANY'S new office building, above. The Company also supplies electric power for Ansonia and Shelton, Connecticut. Progress in power goes hand in hand with progress in the community!

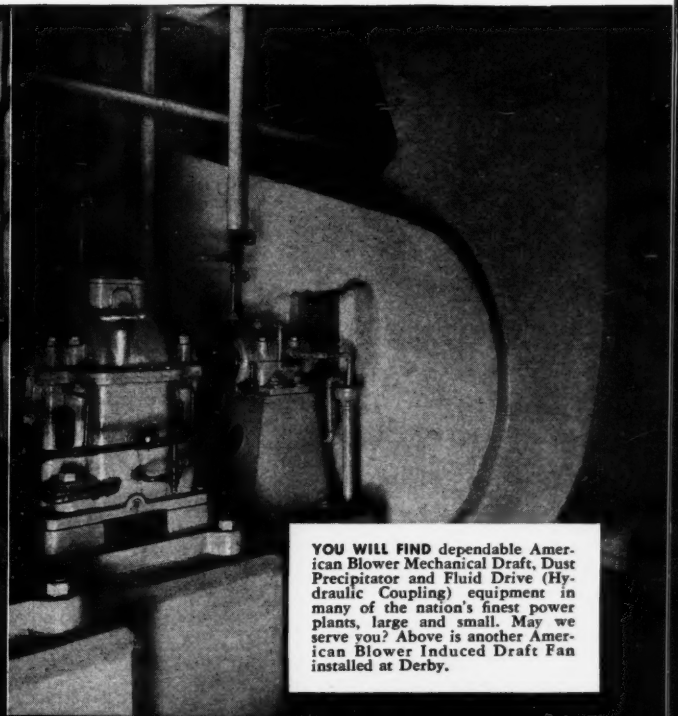
Long before the American Revolution, Derby, Connecticut, was a shipbuilding center, and great sailing vessels in the West Indies trade made the Derby Docks a regular port of call. During the intervening years, it's been "smooth sailing" at Derby. Today, historic Derby is marching ahead with America to new achievements in fast paced industrial production. The city's land and water transportation facilities are a big asset, as always. Of importance, too, are the modern facilities of The Derby Gas and Electric Company . . . bulwarks of democracy, bastions of liberty are located all over the highways and byways of America. And in each of these important centers, just as in Derby, Connecticut, you will invariably find American Blower Forced and Induced Draft Fans, Fluid Drives and Dust Precipitators doing their part, and doing it well.

AMERICAN BLOWER

AMERICAN BLOWER CORPORATION, Detroit, Michigan
CANADIAN SIROCCO COMPANY, LIMITED, WINDSOR, ONTARIO
Division of American Radiator and Standard Sanitary Corporation

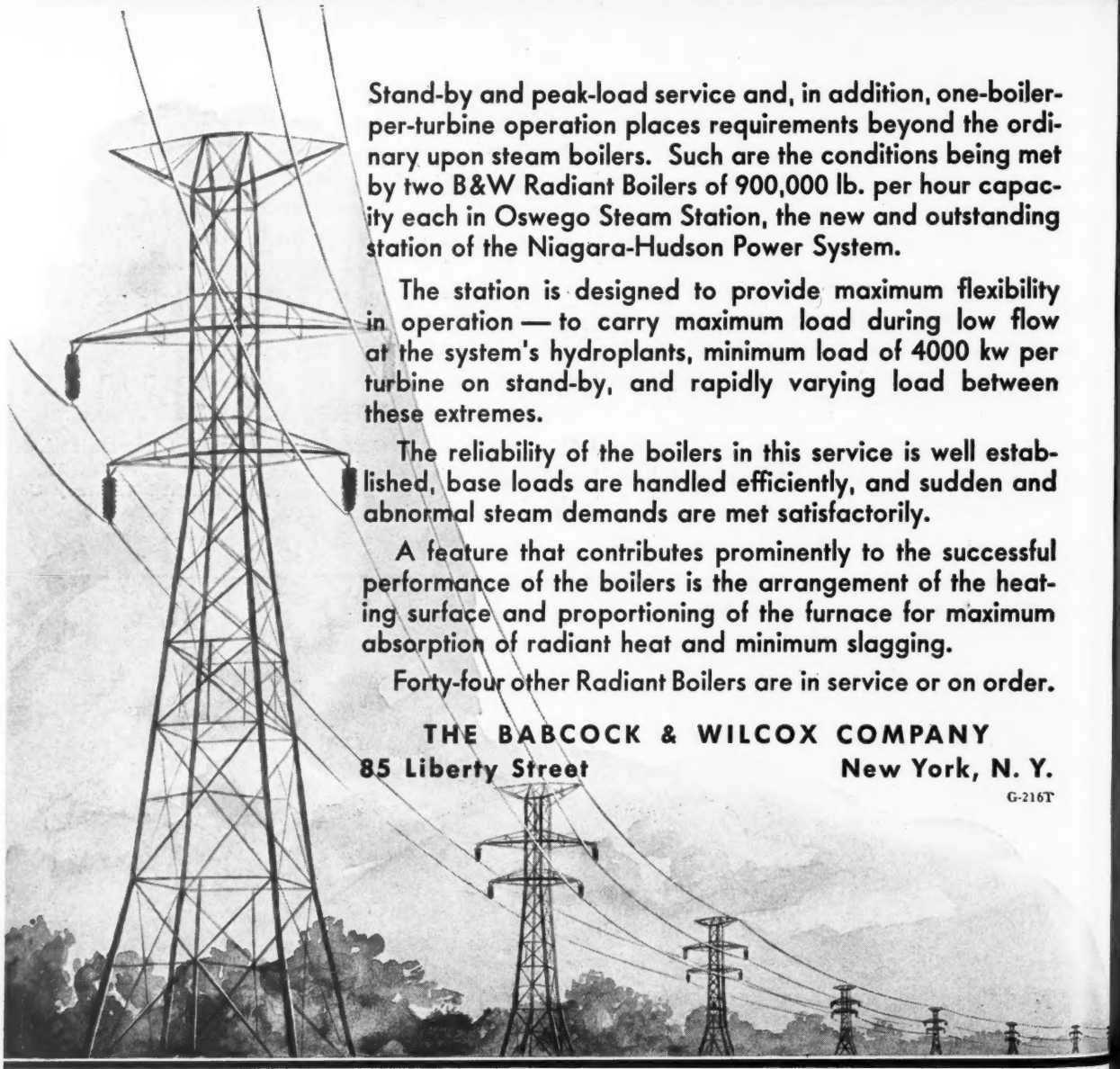


AMERICAN BLOWER Induced Draft Fan installed in the electric generating station of The Derby Gas & Electric Company. This plant also has an American Blower Type ST Dust Precipitator.



YOU WILL FIND dependable American Blower Mechanical Draft, Dust Precipitator and Fluid Drive (Hydraulic Coupling) equipment in many of the nation's finest power plants, large and small. May we serve you? Above is another American Blower Induced Draft Fan installed at Derby.

B&W BOILERS AT OSWEGO
help Niagara carry the load



Stand-by and peak-load service and, in addition, one-boiler-per-turbine operation places requirements beyond the ordinary upon steam boilers. Such are the conditions being met by two B&W Radiant Boilers of 900,000 lb. per hour capacity each in Oswego Steam Station, the new and outstanding station of the Niagara-Hudson Power System.

The station is designed to provide maximum flexibility in operation — to carry maximum load during low flow at the system's hydroplants, minimum load of 4000 kw per turbine on stand-by, and rapidly varying load between these extremes.

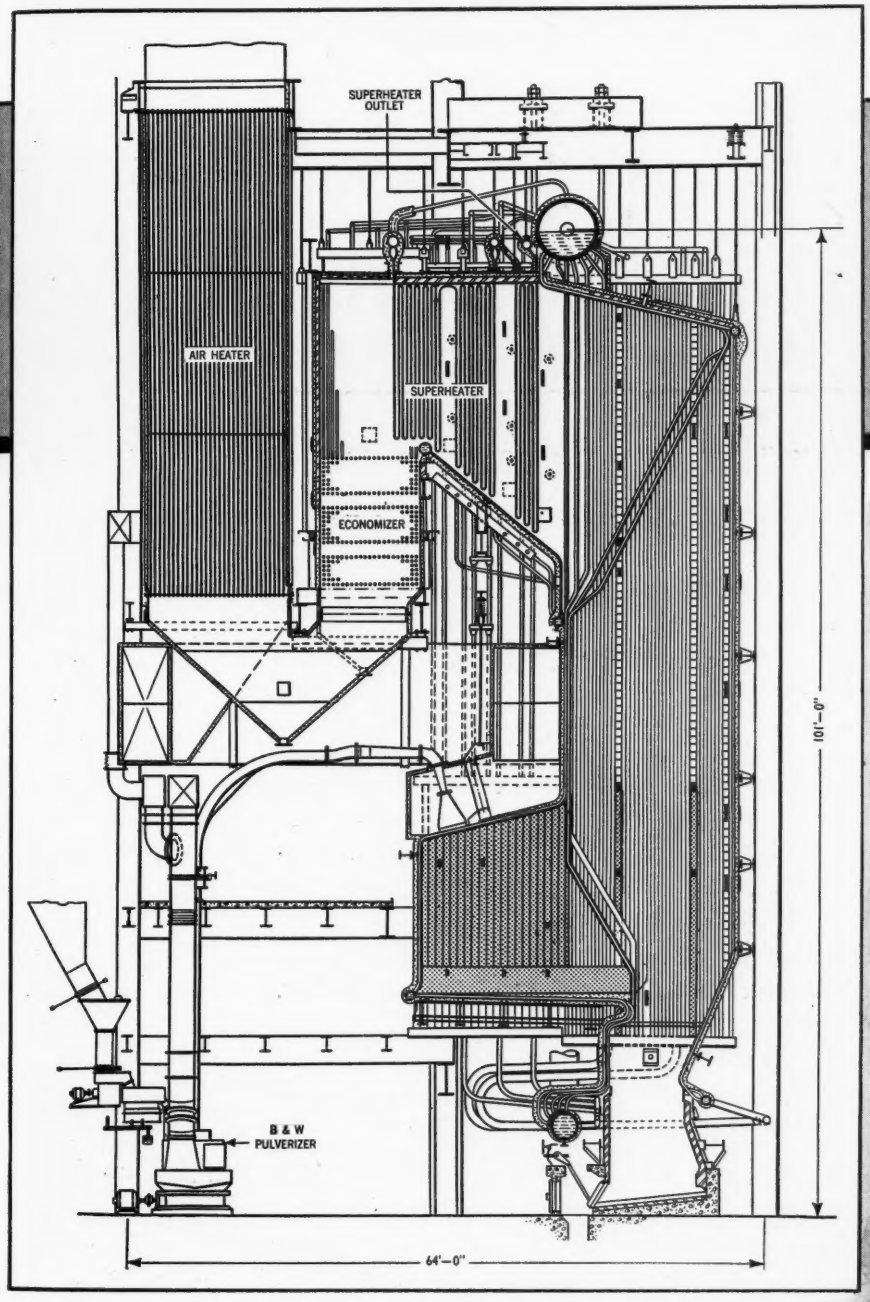
The reliability of the boilers in this service is well established, base loads are handled efficiently, and sudden and abnormal steam demands are met satisfactorily.

A feature that contributes prominently to the successful performance of the boilers is the arrangement of the heating surface and proportioning of the furnace for maximum absorption of radiant heat and minimum slagging.

Forty-four other Radiant Boilers are in service or on order.

THE BABCOCK & WILCOX COMPANY
85 Liberty Street **New York, N. Y.**

G-216T



B&W Radiant Boiler as installed at Oswego.
Capacity 900,000 lb. steam per hr. at 1250 psi and 900 F.

BABCOCK & WILCOX

Keeping a High-Speed Journal "Afloat"...

THE "CORRECT" ANSWER TO AN ESSENTIAL PROBLEM IN DEFENSE POWER PRODUCTION:

Problem: To the naked eye, a steam turbine bearing presents highly polished surfaces. But under a microscope, as you see at the right, these surfaces appear as jagged hills and deep valleys. Clearances between journal and bearing are very close. And as the journal turns, the irregularities tend to interlock and cause friction. If such contact is allowed, bearing surfaces will be quickly destroyed.

Answer: The bearing must be flooded with oil by a circulation system. Rotation of the journal then builds up a hydraulic pressure which, in turn, produces an oil "wedge" thick enough to actually float the bearing.

But just "any" oil won't do here. That's important to remember. Speed, pressure, and heat are severe. And the oil is used over and over again — sometimes for many years — under these conditions.

Gargoyle D. T. E. Oils are made to resist heat and pressure ... to give years of dependable service in steam turbines.

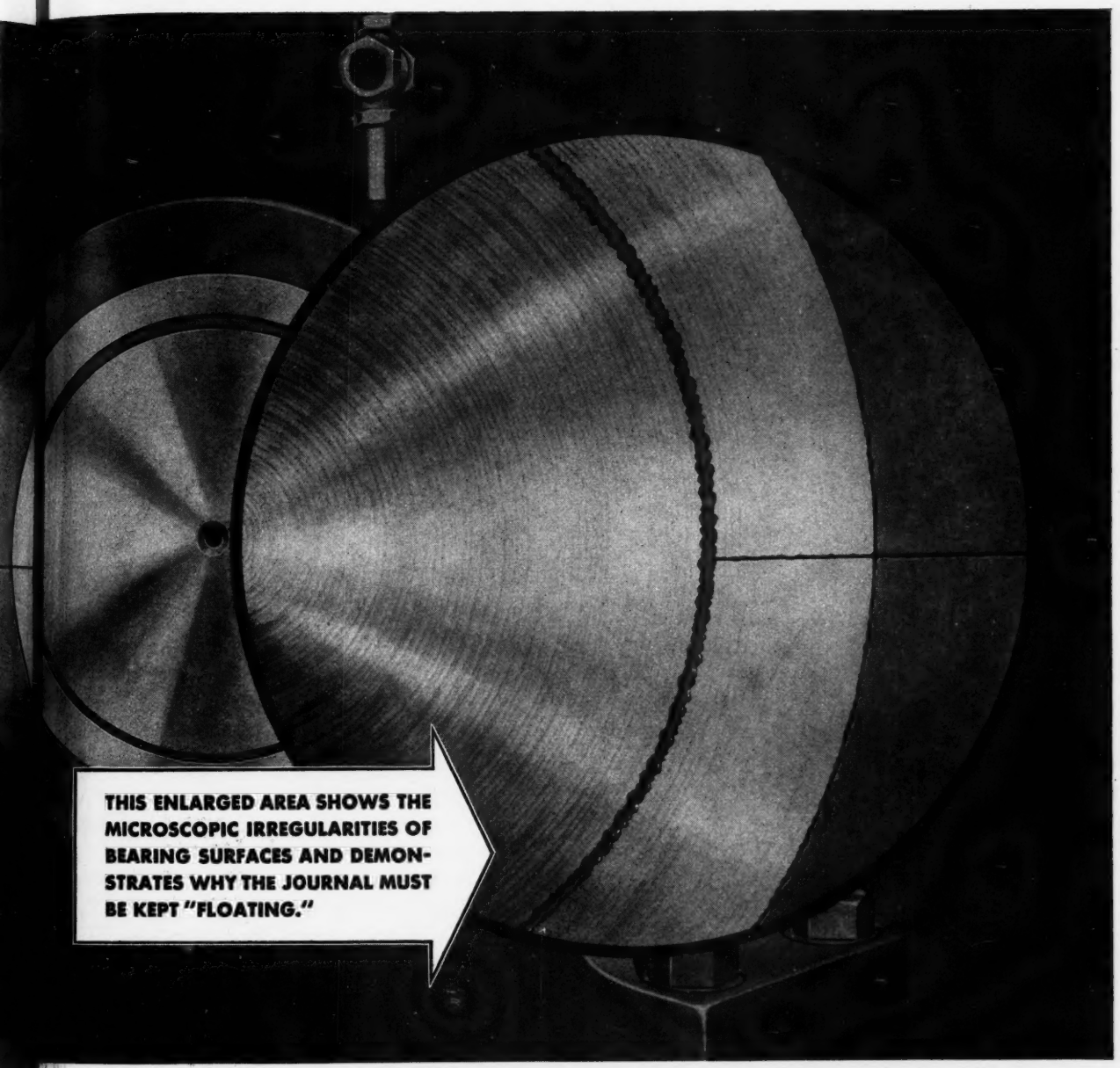
TO HELP MAINTAIN CAPACITY PRODUCTION, CALL IN

SOCONY-VACUUM for "Correct Lubrication"

SOCONY-VACUUM OIL CO., INC. — Standard Oil of N. Y. Div. — White Star Div. Lubrite Div. — Chicago Div. — White Eagle Div. — Wadhams Div. — Southeastern Div. (Baltimore) — Magnolia Petroleum Company — General Petroleum Corporation of Calif.

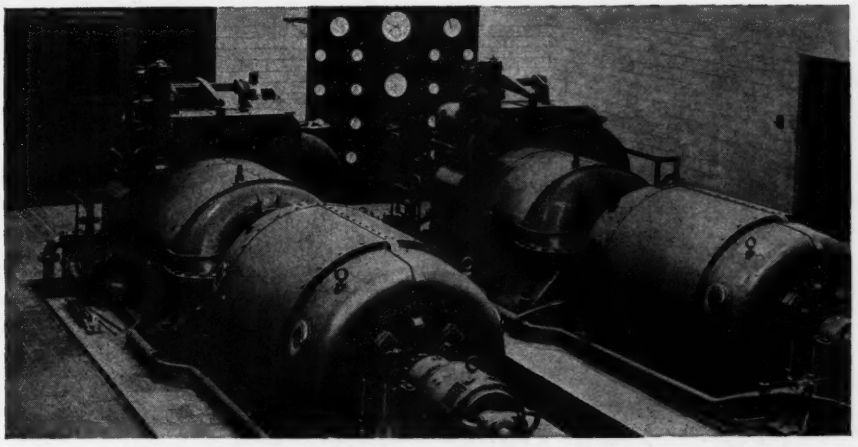
GARGOYLE

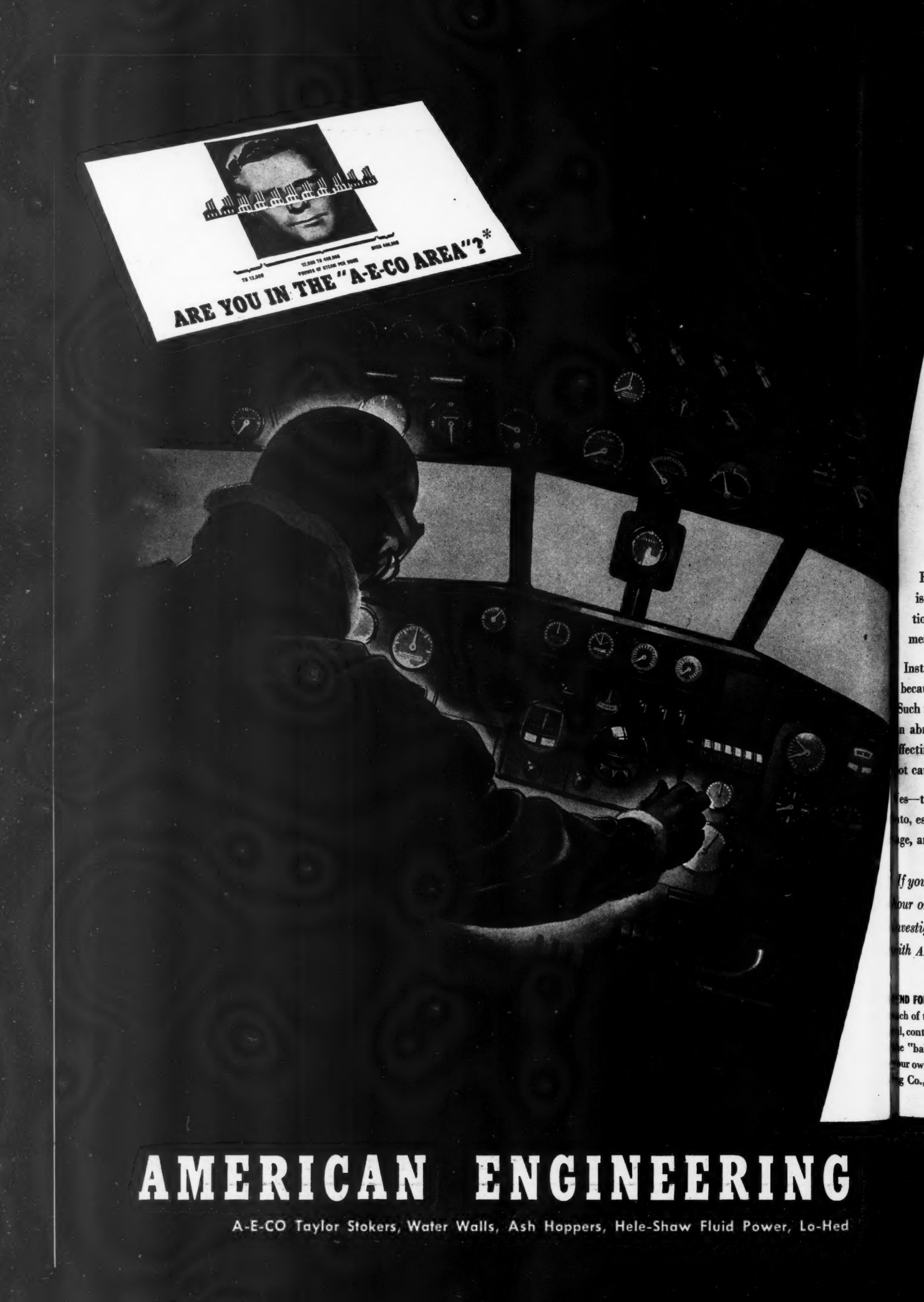
Lubricants



THIS ENLARGED AREA SHOWS THE MICROSCOPIC IRREGULARITIES OF BEARING SURFACES AND DEMONSTRATES WHY THE JOURNAL MUST BE KEPT "FLOATING."

BECAUSE of their stability and fine resistance to oxidation and deposit formation, Gargoyle D. T. E.'s are lubricating more than 50% of the U. S. A.'s major-sized steam turbines—a record unequalled by any other brand.





AMERICAN ENGINEERING

A-E-CO Taylor Stokers, Water Walls, Ash Hoppers, Hele-Shaw Fluid Power, Lo-Hed

NECESSARY? HERE, YES.
BUT NOT IN YOUR STEAM PLANT

Simplification! *This* is the demand of efficiency in industry. The constant observation of adjustment requirements, and the supervision of unnecessary controls is being eliminated wherever possible.

It is another reason for today's trend to today's Taylor Stoker!

Simplicity of operation with completely adequate controls of basic combustion principles is inherent in the Taylor Stoker. Here they are:

The coal and the fuel bed are easily regulated in each retort by a simplified mechanism at the *front* of the stoker—with secondary pusher control that manages the fuel during the several hours it travels on the grate in the complete combustion process.

For larger units and more exacting load demands, the control system is expanded to provide simple, independent adjustment of small sections of the grate area while the unit is still in service. These adjustments are also made from the front of the stoker.

Instantaneous, precise and frequent control becomes unnecessary—because of the constant and dependable reserve energy on the grate. Such reserve allows wide margin—a margin that even will accommodate an abnormal ratio of air and coal for short periods without seriously affecting continuity of service. Momentary failure of coal or air will not cause failure of steaming load.

Yes—the simplified operation of Taylor Stokers is well worth looking into, especially if you are in the A-E-CO Area. Compare this advantage, and all others, with *all* types of fuel firing equipment.

If you operate between 12,000 and 400,000 pounds of steam per hour or more, you are in the A-E-CO Area! You must carefully investigate and compare every advantage of today's Taylor Stoker with ANY other fuel burning equipment!

SEND FOR FREE BULLETINS—giving facts on each of the 12 factors influencing economical, continuous steam generation. Indicates the "balance of power" requirements for your own plant. Write American Engineering Co., 2408 Aramingo Ave., Phila., Pa.

Use These 12 Factors as a "Check Chart" in Demanding FACTS About Any Fuel Firing Equipment

RELIABILITY The Taylor Stoker has a 35 year record of reliability of which 92.7% is typical.

CAPACITY Emergency reserve capacity is readily available over long periods of operation.

MAINTENANCE Average is 3.4c per ton based on a recent study of a typical group of plants.

FLEXIBILITY From 40,000 to 300,000 lbs/hr in 72 seconds. Cold boiler, no fire, to 250% rating in 20 minutes.

EFFICIENCY 16.73c for fuel per thousand pounds of steam is indication of A-E-CO Taylor Stoker "dollar" efficiency.

OPERATION Simplest of any. No complicated adjustments. Coal direct from mine to hopper.

ADAPTABILITY Modernization can be accomplished without seriously disturbing existing plant structure.

FUEL FLEXIBILITY Handles coals of widely varying characteristics; detailed list on request.

REFUSE DISPOSAL Choice of 3 methods; power dump, continuous and rotary.

STACK DISCHARGE 90% average of ash to ash pit. Dust-recovery equipment rarely used—even in heart of city locations.

SPACE REQUIREMENTS Conforms to short and wide, or long and narrow furnaces.

OBSOLESCENSE One basic design used for 35 years enables new improvements to be added to numerous existing installations.

THE A-E-CO Taylor Stoker

COMPANY

Hoists, Marine Deck Auxiliaries

ARMSTRONG "INVERTED BUCKET" STEAM TRAP

TRADE MARK

Saving FUEL,

Easy TO INSTALL...

• 3,470,000 cu. ft. of gas saved in a month by 17 Armstrong traps installed at the Heineman Chemical Co., Crosby, Pa.! 800 gallons of fuel oil saved in a week by 16 Armstrong traps just installed at Midland Chemical Laboratories, Inc., Dubuque, Iowa! A ton of coal saved a day and 95% reduction in maintenance credited to 50 traps put in by R. Thomas & Sons Co., Lisbon, Ohio.

These are just a few of the many reports of benefits secured. What this means to a nation now bending every effort to get maximum results out of every unit of fuel, metal and manpower can be better visualized by translating it into terms of Armstrong's annual output of traps.

14,000 cars of coal . . . 68 five thousand ton shiploads of oil might otherwise be expended for non-productive work. As much as 10,000,000 pounds of steel might be required for extra boiler capacity to burn the fuel and generate the steam going into this non-productive work. And to the accompanying expenditure of manpower would be added thousands of hours for maintenance of old traps and drainage systems.

ARMSTRONG TRAPS PAY FOR THEMSELVES MANY TIMES OVER IN SAVINGS OF FUEL, METALS, AND MANPOWER.

ARMSTRONG MACHINE WORKS
810 Maple Street — Three Rivers, Michigan

ASK FOR A COPY OF THE ARMSTRONG STEAM TRAP BOOK

THOUSANDS of engineers use this book to get all information needed to handle ordinary piping, heating, and drainage engineering jobs. It contains a wealth of tables, charts, curves, diagrams, etc. We will be glad to send you a copy without obligation.

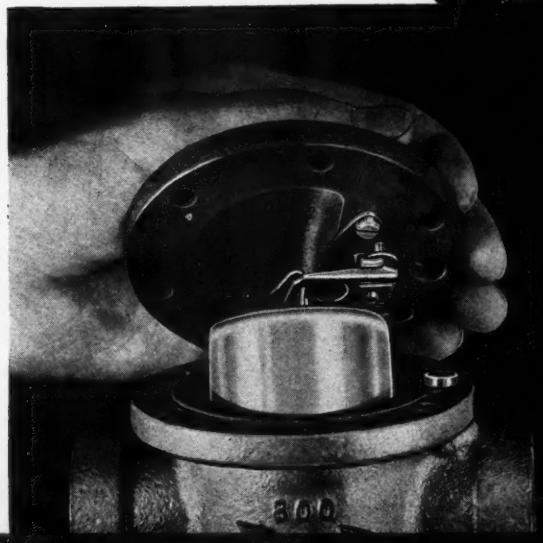
SEE OUR CATALOG IN SWEET'S

USE ARMSTRONG

METALS and MANPOWER

Easy TO INSPECT!

the Cap Carries the "Whole Works"



BUILT FOR YOUR CONVENIENCE

1. **PIPE CONNECTIONS IN BODY — NOT IN CAP.** Armstrong "800 Series" Side Inlet Traps embody the advanced design pioneered by Armstrong. Never any need to break pipe connections. Merely by loosening the cap, the entire operating mechanism is free to lift out for easy, convenient inspection.

2. **CHOICE OF BODY STYLES.** As the job dictates, you are free to choose the body style that fits in best with your piping arrangement: "800 Series" side inlet traps are popular for horizontal piping runs, "200 Series" bottom inlet traps for vertical runs — particularly where trap discharges to an overhead return line.

3. **NO PRIME-HANDLING NUISANCE.** In neither type of Armstrong trap are you presented with any problem of disposing of a body full of hot prime when you want to open up a trap. In both types, the body stays in the line.

4. **EASY TO TEST OPERATION.** All Armstrong Traps in the 200 and 800 Series have test plugs located directly over the discharge orifices. Few users ever need this feature but it's there for your convenience!

5. **SELF-SCRUBBING . . . NON-AIRBINDING . . . ALL-STAINLESS STEEL INTERIOR MECHANISM.** These are all features that protect you against annoying time waste and expense.

STEAM TRAPS

New York City's new $19,000,000, 17 story

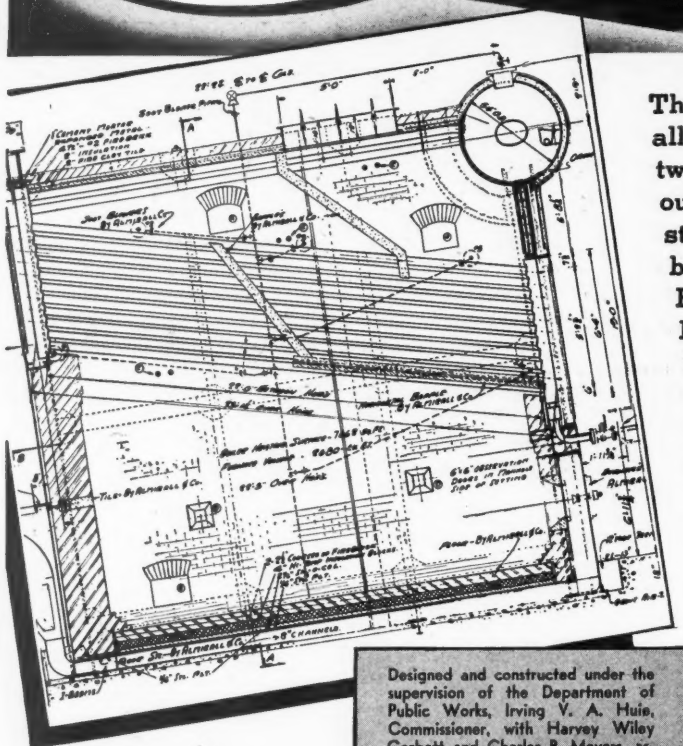
CRIMINAL COURTS BLDG. AND CITY PRISON

Served by

4 VOGT

Forged Steel

SECTIONAL HEADER BOILERS



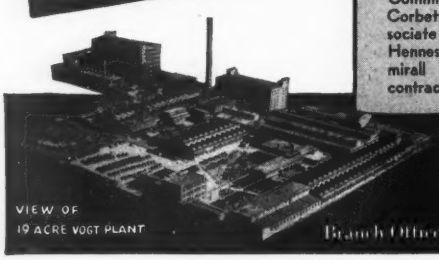
Designed and constructed under the supervision of the Department of Public Works, Irving V. A. Huie, Commissioner, with Harvey Wiley Corbett and Charles B. Meyers, associate architects, and Syska & Hennessy, consulting engineers. Almirall & Company, Inc., heating contractors.

Thirty Court Rooms and Jury Rooms, all completely air conditioned, and a twelve story Prison are housed in this outstanding Public Building. All the steam requirements will be supplied by four Vogt Sectional Header Boilers.

Each steam generating unit has 7,062 sq. ft. of heating surface designed to generate 47,000 pounds of steam per hour at 200% rating, using oil for fuel. Headers, forged from seamless steel tubing, and the fusion welded steam drum are designed for 200 pounds working pressure.

•

Vogt builds steam generating equipment in many types and sizes to meet every heating, power, or processing requirement.

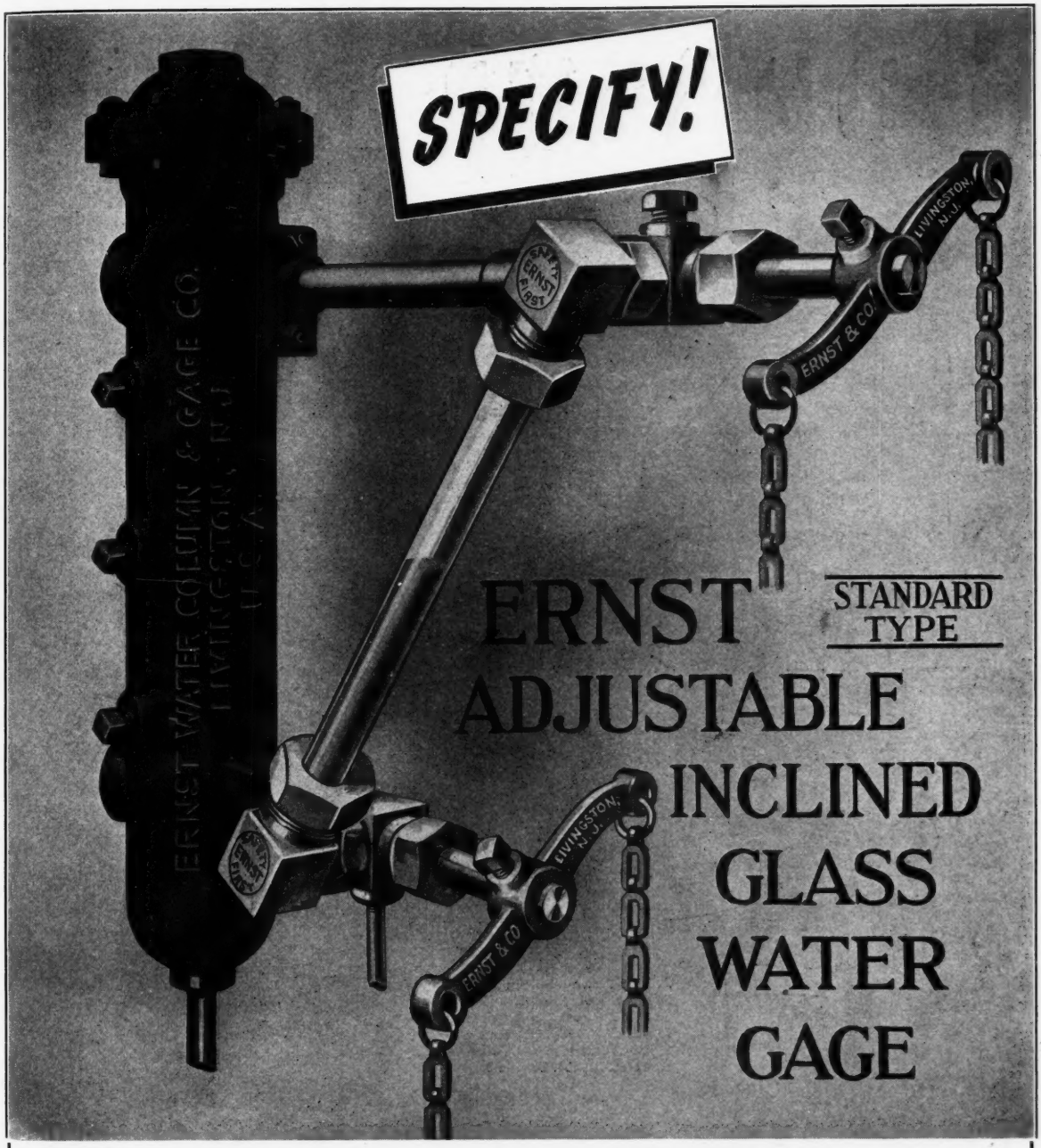


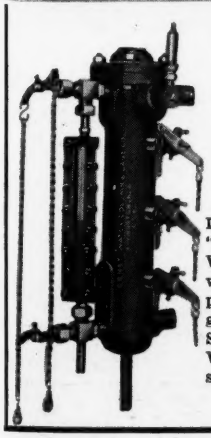
VIEW OF
19 ACRE VOGT PLANT

HENRY VOGT MACHINE CO., Inc.

LOUISVILLE, KY.

Branch Offices: New York · Philadelphia · Cleveland · Chicago · Cincinnati · St. Louis · Dallas





Illustrates Ernst "Standard Type" Vertical gage with "C-Black" prismatic flat glass insert; Steam shows WHITE, water shows Black.

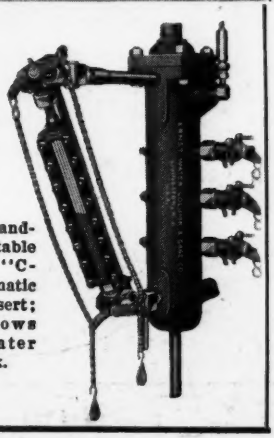
FOR ALL PRESSURES AND TEMPERATURES

Modern Design Water Column Equipment

"SPLIT-GLAND" GAGE GLASS FITTINGS HAVE NO GAGE GLASS PACKING NUTS

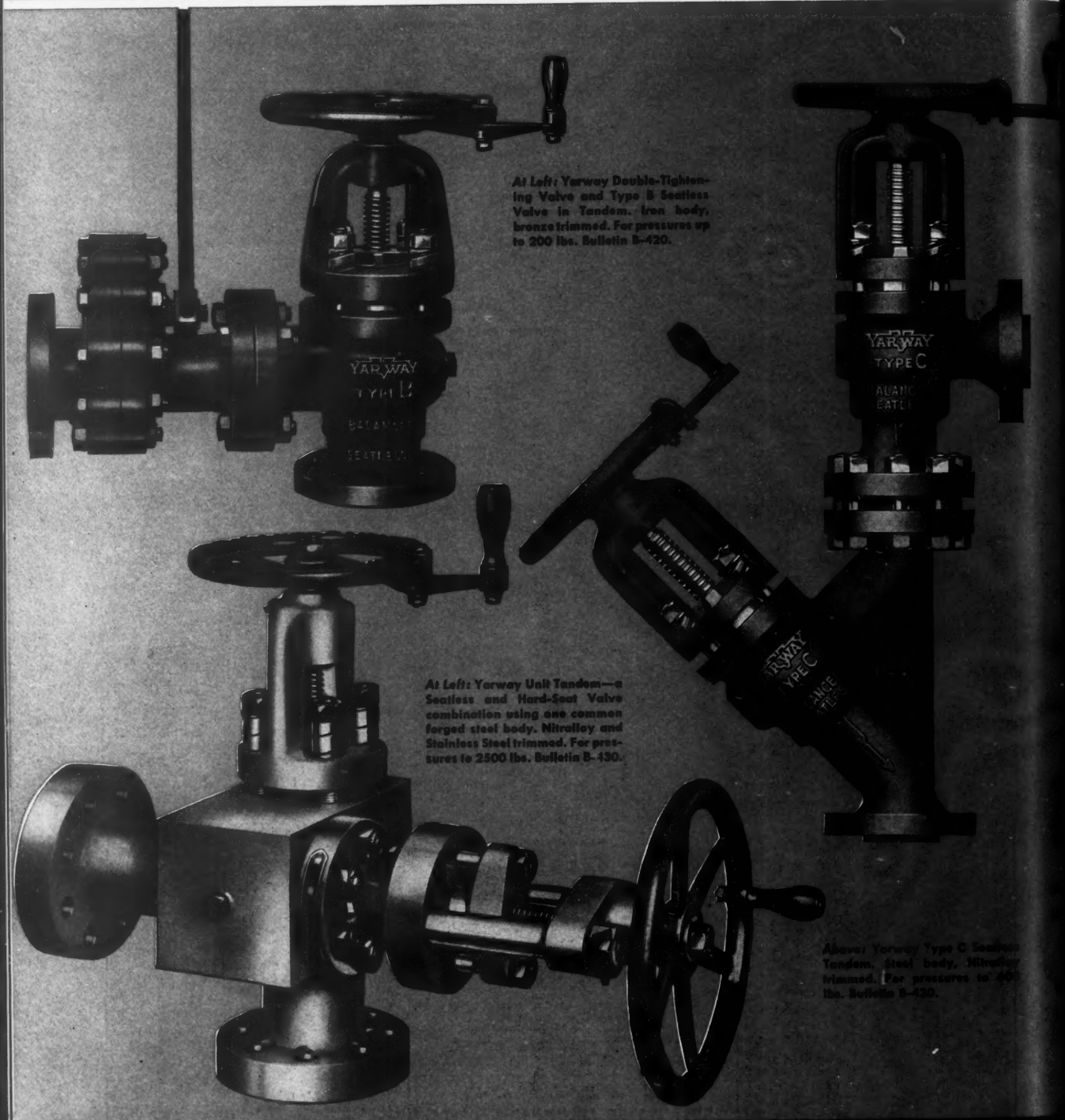
Send for Catalog No. 45

ERNST WATER COLUMN & GAGE CO.
LIVINGSTON, NEW JERSEY
Manufacturing For More Than 35 Years



Illustrates Standard Adjustable Inclined "C-Black" prismatic flat glass insert; Steam shows WHITE, water shows Black.

Back of Every



At Left: Yarway Double-Tightening Valve and Type B Seatless Valve in Tandem. Iron body, bronze trimmed. For pressures up to 200 lbs. Bulletin B-420.

At Left: Yarway Unit Tandem—a Seatless and Hard-Seat Valve combination using one common forged steel body. Nitralloy and Stainless Steel trimmed. For pressures to 2500 lbs. Bulletin B-430.

Above: Yarway Type C Seatless Tandem. Steel body, Nitralloy trimmed. For pressures to 600 lbs. Bulletin B-430.

YARWAY

YARWAY Product

Sound Engineering Design, Complete Laboratory Tests, Proven Field Performance

THE YARWAY 2500 lb pressure steam laboratory makes possible the testing of every product to the ultimate of service it will be called upon to perform in your plant.

Ample margins of safety are provided not only to meet today's standards but tomorrow's possibilities as well.

Convenience and economy of operation based on sound engineering principles also are provided.

Yarway products are designed for long, trouble-free service—built up to a standard, not down to a price. This is especially important in accessories which become an integral part of major equipment and affect the performance of such primary units.

You invest in complete protection when you invest in Yarway-engineered products.

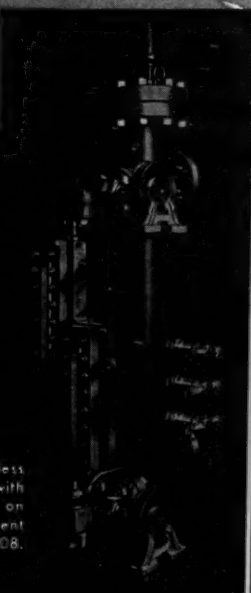
You should have all Yarway catalogs in your library for ready reference—yours for the asking.

YARNALL-WARING COMPANY
114 Mermaid Ave. • Philadelphia, Pa.

Above: The Yarway Impulse Steam Trap has only one moving part; no buckets, bellows, levers or floats. Bulletin T-1735.

Below: The Yarway Involute Spray Nozzle is non-clogging, trouble-free. No internal parts; contour of body guides flow in an involute path. For cooling condenser water and for air conditioning service. Bulletin N-616.

Above: The Yarway Gun-Pakt Expansion Joint may be re-packed under full steam pressure and never needs unpacking. Bulletin EJ-1907.



Right: The Yarway floatless Water Column operates with balanced solid weights, on the well-known displacement principle. Bulletin WG-1808.

STEAM SPECIALTIES

"Retreaded" for the duration

APEXIOR keeps border-line boilers in service indefinitely

Like those precious tires you are retreading for longer service, boiler tubes and drums *must* be guarded for extended operation . . . What man can foresee when new power equipment will be readily available?

Any boiler — now inactive or even nearing condemnation — that can withstand the required hydrostatic test after being cleaned, can be APEXIORIZED and kept in continuous service with reasonable care.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

A Durable, Renewable Surface

APEXIOR No. 1 puts a protective, added wearing surface on bare boiler metal. *This* surface, instead of the metal, takes the beating and resists corrosion — a surface that can be easily renewed with a hand brush or a power coater. Scale cannot bond tightly with an APEXIORIZED surface, brush-cleaning is simple and quick.

APEXIOR Guarantees Good Metal Condition — no other protection offers the same assurance and security

For years, APEXIOR has been used on steam boiler and turbine equipment by men who demand the utmost in power plant protection and efficiency.

Now — if never before — you should investigate the APEXIOR method of keeping old equipment alive, and ensuring maximum service from new installations.

Recommended by all U. S. and Canadian boiler insurance companies

Write for Bulletin 1290

APEXIOR REG U.S. PAT. OFF.

These tubes and the drum metal have been coated with APEXIOR No. 1 by unskilled help in a small plant. They can be cleaned with a wire brush. No new tubes will be needed as long as the coating is maintained.

A single coat re-application every two or three years with a hand or rotating brush will keep this boiler in efficient service for a long time to come.

THE DAMPNEY COMPANY OF AMERICA

PROTECTIVE COATINGS FOR STATIONARY BOILERS, LOCOMOTIVES AND STEAMSHIPS

HYDE PARK · BOSTON · MASSACHUSETTS

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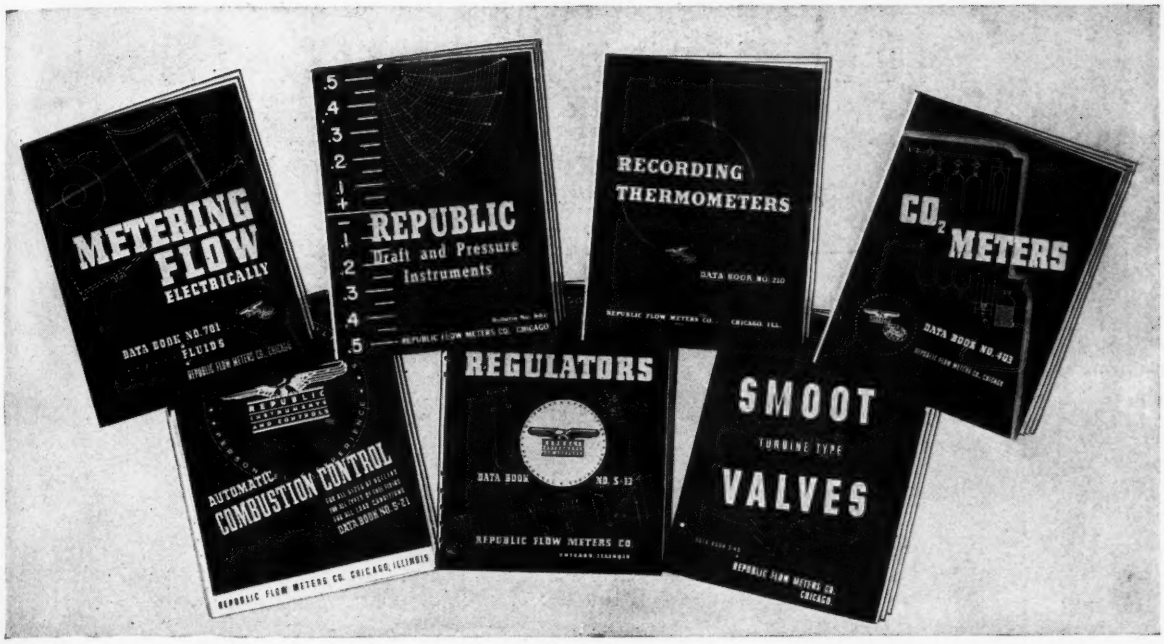
Engineering Sales Representatives — Pittsburgh, Cincinnati, New Orleans, San Francisco, Los Angeles, Portland, Seattle, Phoenix, Denver, Salt Lake City, Dallas, Houston, Vancouver, B. C., Montreal, P. Q., Havana, Cuba, Manila, P. I., Honolulu, T. H., Marine Dept., 114 Liberty Street, New York, N. Y.



These Data Books
WILL HELP YOU SOLVE YOUR POWER PROBLEMS

Write for these data books now! When your increased power load demands the installation of new units or the "stretching" of existing plant capacity, you will need this information.

REMOTE READING FLOW METERS—Data Book No. 701

For measuring flow of steam generated by each boiler and the total produced; steam consumed by prime movers and process steam consuming units; water supplied to boilers and pumped to processes; rate of generation, distribution and consumption of natural gas, coke oven gas, compressed air and the like; flow of fuel oil, brine, black liquor and so on; the Republic electrical type flow meter with remote reading instruments, as described in this book, is available.

MECHANICAL FLOW METERS—Bulletin No. 110

When it is desired to measure flow of steam, water, gas, air or oil for the same purposes as outlined above but where remote registration is not required, the Republic mechanical ring-balance meter described in this book is available. Since it may be built for differentials as low as 3 in. of water, it is ideal for low-pressure gas and air.

DRAFT AND PRESSURE INSTRUMENTS—Bulletin No. 801

Proper regulation of draft is one of the most important requirements in obtaining highest combustion efficiency. For indicating and recording drafts, pressures and differentials, Republic indicators and recorders, described in detail in this bulletin, are supplied in any desired combination for all ranges encountered in furnace operation.

RECORDING THERMOMETERS—Data Book No. 210

Measurements of temperature of flue gas, temperature in vats or tanks, pipe lines, refrigeration systems, ovens, kilns or ducts and so on, are vital in maintaining highest capacity and efficiency in power plant and process equipment. Republic recording thermometers for this service are described in this data book.

CO_2 METERS—Data Book No. 403

For every fuel and boiler, there is a definite percentage of CO_2 in the flue gas that will assure highest combustion efficiency. The CO_2 meter is the most practical method of determining combustion efficiency. The construction and operation of the Republic CO_2 meter are described in detail in this book.

REGULATORS—Data Book No. S-13

Control of rate of flow of liquids and gases, level of liquids, speed of turbines, engines and motors and proportions between variable pressures and flows must be accurate if maximum plant efficiency is to be attained. These factors are controlled by operation of valves, dampers, rheostats, etc. For sensitive, fast, stable and powerful automatic control of these devices, the Republic-Smoot regulator has been developed. Its construction, operation and applications are described in this book.

AUTOMATIC COMBUSTION CONTROLS—Data Book No. S-21

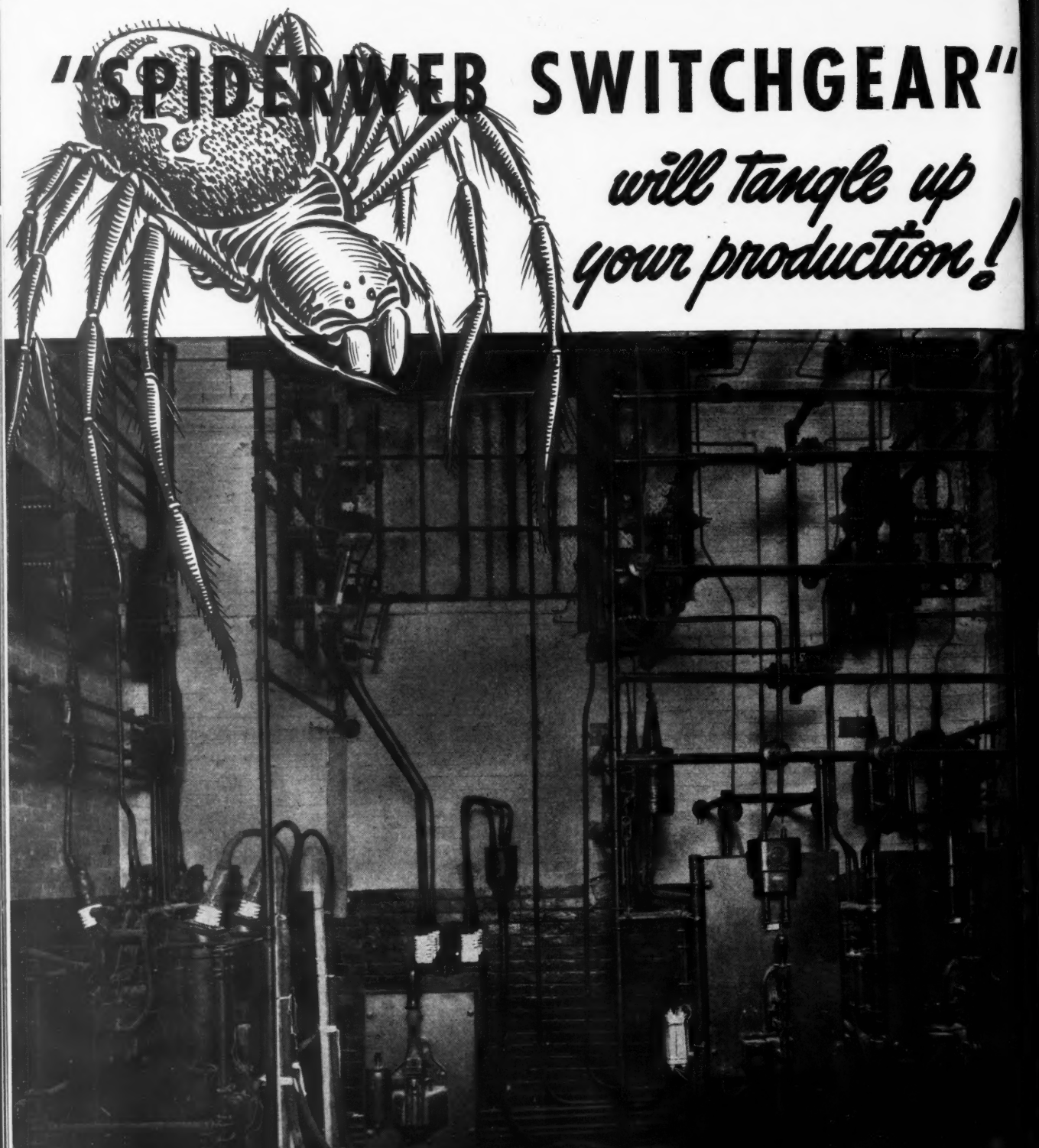
Boilers must produce maximum steam output at maximum efficiency. That means constant steam pressure, maximum combustion efficiency, constant and correct furnace draft, desired load division among boilers. Republic-Smoot automatic combustion control systems are built for all sizes of boilers, all types of fuel firing and all load conditions, as described in this book, which includes detailed installation reports giving performance data on outstanding power plants.

WRITE FOR THESE DATA BOOKS TODAY!

REPUBLIC FLOW METERS CO.
2224 Diversey Parkway, Chicago, Illinois

"SPIDERWEB SWITCHGEAR"

will tangle up your production!



ALL YOUR POWER GOES THROUGH YOUR SWITCHGEAR

Here's the METAL-CLAD ANSWER

Completely Enclosed in Grounded Metal—to Protect Your Personnel and Safeguard Continuous Production

You Get All This:-

COMPLETE CO-ORDINATION of switchgear devices. All the devices are designed to operate as a unit.

LOW PREDICTABLE INSTALLATION TIME—AND COST. The equipment is *complete* and ready to install as a unit.

SAFETY. All conducting parts are amply insulated, and located behind grounded walls of metal. Every part is made to withstand short-circuit stresses equal to the rating of the breaker.

EASY, SAFE INSPECTION. The breakers are easily removable, and can be withdrawn and replaced in a few minutes. You can inspect them away from all live parts.

Write for Bulletins GEA-2499 and GEA-3083 (up to 15 kv) and GEA-2249 (up to 5 kv). General Electric Company, Schenectady, N. Y.

General Electric and its employees are proud of the Navy award of Excellence made to its Erie Works for the manufacture of naval ordnance.

GENERAL ELECTRIC

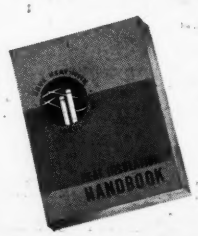
GETTING THE *MOST* FROM YOUR THERMAL INSULATIONS...

MAKE SURE THE MATERIAL
IS RIGHT FOR THE SERVICE...
NUMBER 1 in a series of messages to American industry devoted to conserving heat, improving operation and increasing production through modern insulation practice.

There can be no compromise in specifying the fabric for a parachute—for obvious reasons. And thermal insulations, which are industries' protection against heat loss, should be as carefully chosen for the temperatures and service conditions involved. The failure of an improperly used insulation is seldom dramatic, but always costly.

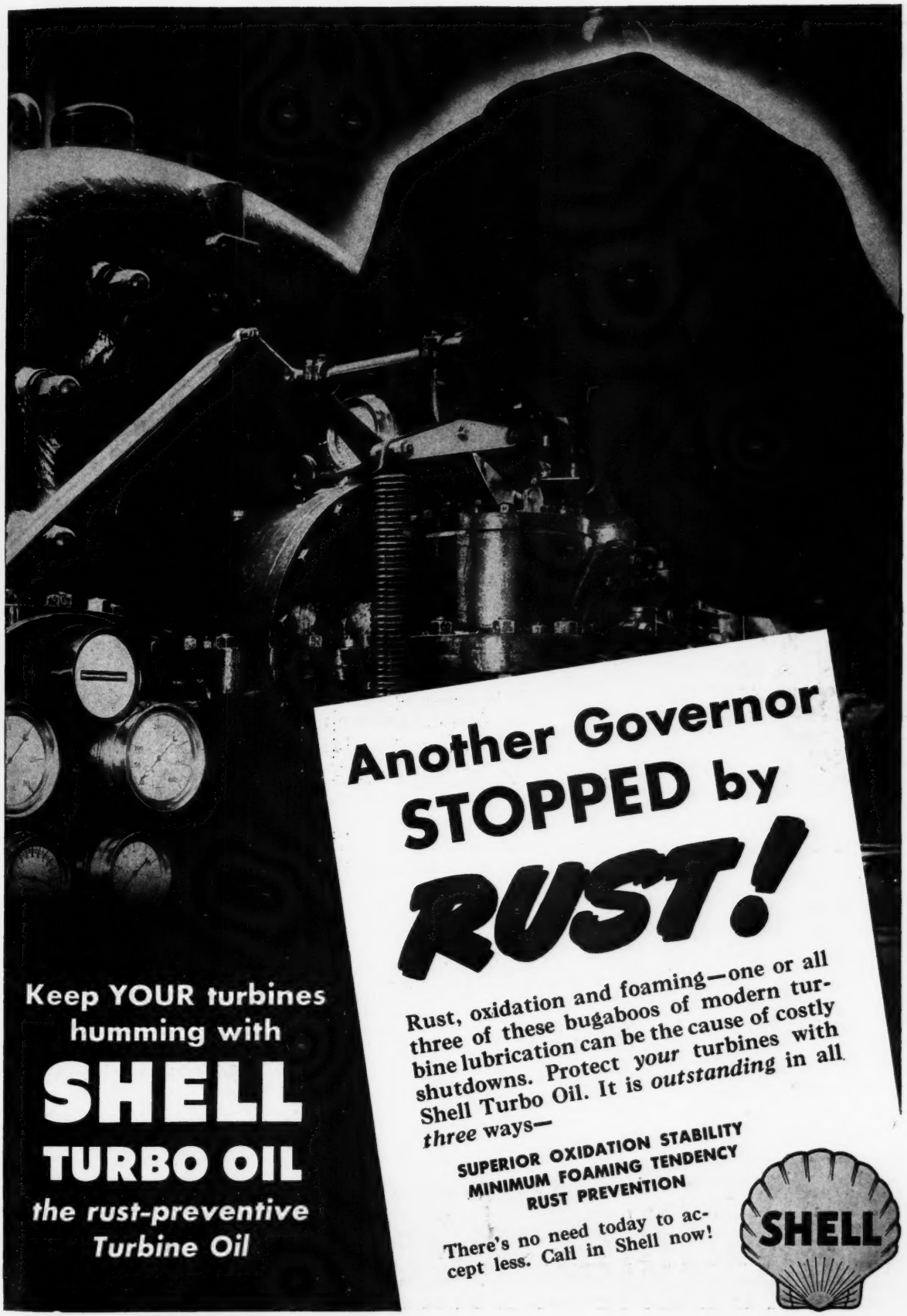
In times like these, when increases in steam pressures and process temperatures are the rule, it is sound practice to check your present insulating materials—and your insulation requirements—and to specify the proper Ehret insulation for your particular service needs.

★ **EHRET'S 85% MAGNESIA** and many other Ehret heat insulating materials are fully treated, both as to selection and application, in the new 176 page Heat Insulation Handbook. It will be furnished, without obligation, to those interested in getting the most from their thermal insulations. Write today for your copy of Handbook B-202.



EHRET MAGNESIA MANUFACTURING CO.
VALLEY FORGE, PENNA.

...THERE IS AN *EHRET* DISTRIBUTOR OR CONTRACTOR IN EVERY INDUSTRIAL AREA



Another Governor STOPPED by RUST!

Rust, oxidation and foaming—one or all three of these bugaboos of modern turbine lubrication can be the cause of costly shutdowns. Protect *your* turbines with Shell Turbo Oil. It is *outstanding* in all *three* ways—

SUPERIOR OXIDATION STABILITY
MINIMUM FOAMING TENDENCY
RUST PREVENTION

There's no need today to accept less. Call in Shell now!

Keep YOUR turbines humming with

SHELL TURBO OIL

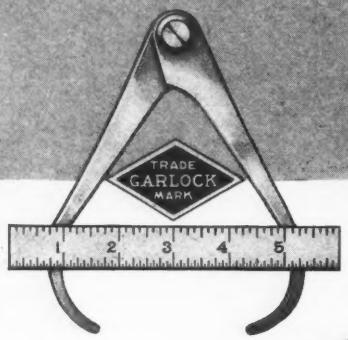
the rust-preventive Turbine Oil

SHELL

Today, more than ever, it is Vital to

AVOID FREQUENT SHUTDOWNS

For Replacement of Packings and Gaskets

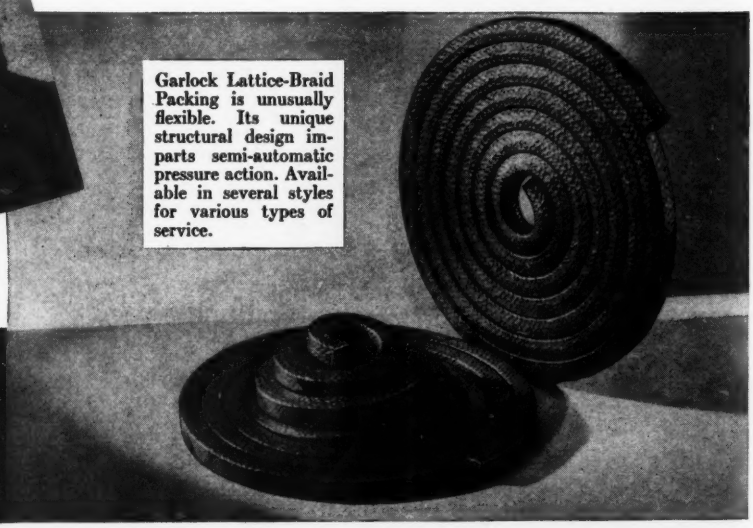


GARLOCK packings and gaskets give long, dependable performance month after month because of our *quality-controlled* method of manufacture.

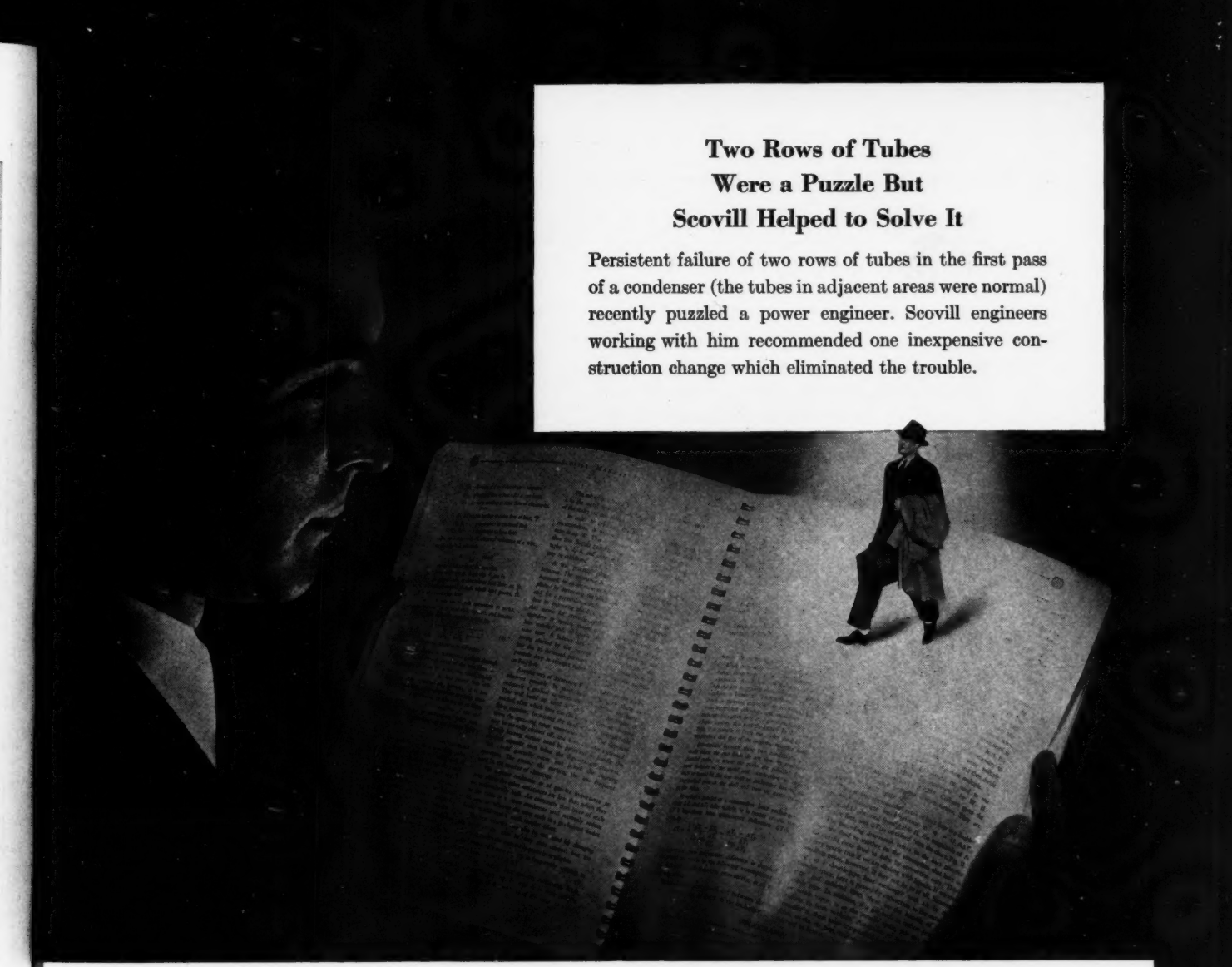
Avoid frequent shut-downs for re-packing and for replacement of gaskets. Standardize on GARLOCK!

THE GARLOCK PACKING COMPANY, PALMYRA, N.Y.
In Canada: The Garlock Packing Company of Canada Limited, Montreal, Que.

Garlock Lattice-Braid Packing is unusually flexible. Its unique structural design imparts semi-automatic pressure action. Available in several styles for various types of service.



GARLOCK



Two Rows of Tubes Were a Puzzle But Scovill Helped to Solve It

Persistent failure of two rows of tubes in the first pass of a condenser (the tubes in adjacent areas were normal) recently puzzled a power engineer. Scovill engineers working with him recommended one inexpensive construction change which eliminated the trouble.

Call on the man between the lines

To Help Solve Your Condenser Tube Problems

$$R = \frac{Dvp}{u} = \frac{DG}{u}$$

. . . and the combined experience of the men who serve Scovill heat exchanger customers is almost sure to equal a practical, economical solution of any tube difficulties you may encounter.

Much of this combined knowledge is contained in our new Heat Exchanger Tube Manual; but beyond that, you'll find the man *between the lines* well qualified to help you in your special problems whether it be corrosion of metals, methods of installation, fluid flow, heat transfer, or specifications.

Should that problem involve Reynolds' number . . . the transition point between viscous and turbulent flow . . . dezincification . . . vaporization . . . or merely the standard tolerances for seamless tubing . . . we can probably promptly supply exactly the information you need — background information that springs from the practical experience of Scovill consultants who have helped to solve problems like yours.

The revised edition of the Scovill "Heat Exchanger Tube Manual" is reserved for distribution to engineers and other technical men whose positions frequently require them to have access to a source of material which covers many of the more unusual aspects of heat exchanger tube engineering and operation.

For an informative source for those problems having to do with the manufacture, material selection and installation of Condenser Tubes, Scovill's Service in Manuals has produced another booklet — "Scovill Condenser Tubes" available on request. Write to Scovill Manufacturing Company, 17 Mill St., Waterbury, Conn.

★ ★ ★ ★ ★ ★ ★

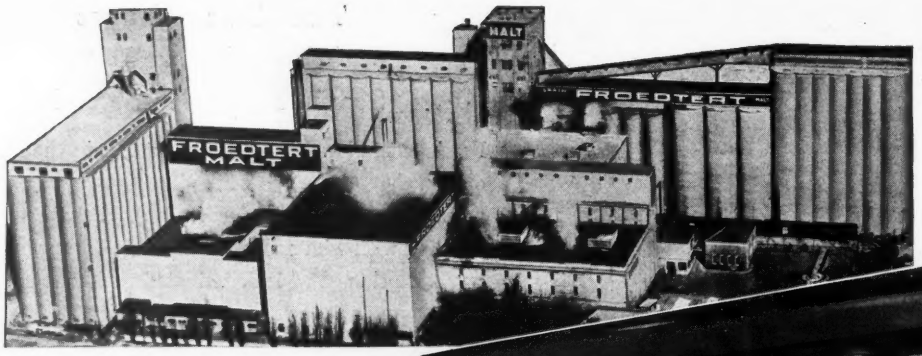
Scovill, for many years a regular source of supply for the U. S. Government, is cooperating in every way to forward defense plans. When deliveries are not as prompt as our customers desire, we hope they will realize that delays are sometimes unavoidable, and part of the price paid for National Defense.

SCOVILL
Masters of Metal

Scovill Condenser Tubes

ONE PRODUCT...THREE SERVICES

- **SERVICE IN MEN**
- **SERVICE IN METALS**
- **SERVICE IN MANUALS**



World's Largest Malting Company MODERNIZES WITH HAYS

FROEDTERT Grain & Malting Company, Milwaukee is the largest in the world with a yearly production capacity of 12,000,000 bushels and elevator and storage capacity of 9,000,000 bushels. Above is view of Hays Centralized Combustion Control panel. Arthur G. Behling was the consulting engineer on the boiler house extension.

FROEDTERT GRAIN & MALTING COMPANY of Milwaukee began a power plant rebuilding program in 1940—the fifth power modernization made necessary through nearly 60 years of growth. A complete new boiler plant was installed in 1941 consisting of two 6500 sq. ft. 3-drum, 3 pass, water-tube boilers with superheaters, economizers and water cooled furnaces fired by multiple-retort underfeed stokers. A complete Hays system of automatic combustion control centralized on a boiler operating panel maintains highest operating efficiency with steam pressure held constant regardless of load. The entire system is electrically operated with provision made for switching instantaneously from automatic to manual operation.

"Through this modernization program" says Lloyd A. Corwin, Chief Engineer and General Superintendent, "operation has been improved by permitting use of low priced fuel, by increasing power and steam output and by eliminating use of live steam for process."

HAYS

Automatic
COMBUSTION CONTROL
THE MODERN SYSTEM—*it's Electric!*

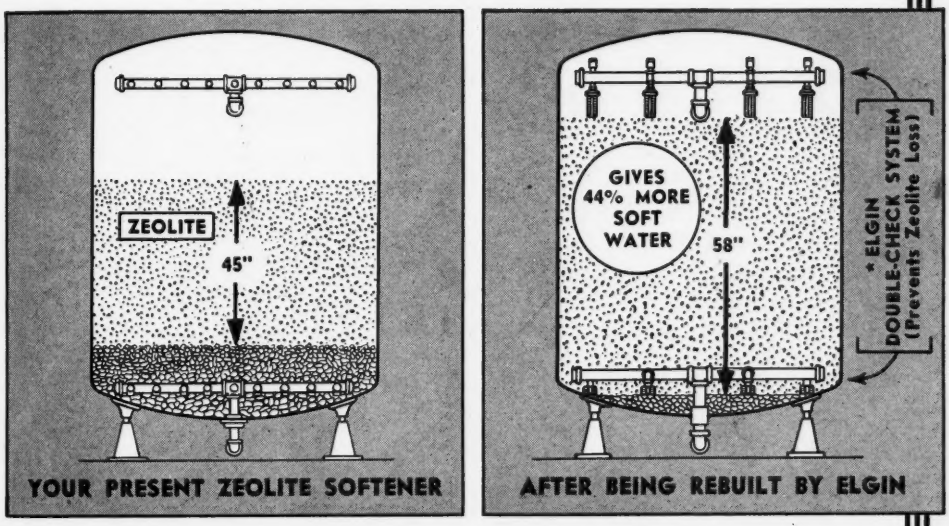
THE HAYS CORPORATION • • • MICHIGAN CITY, INDIANA

Steel saved in SOFTENER tanks can be used in FIGHTING tanks

Elgin "Double-Check" method of getting*

44% INCREASED CAPACITY FROM YOUR PRESENT WATER SOFTENER

means more than ever now!



(You can use your present zeolite mineral)

FOR EXAMPLE—Suppose you have a 48"x72" water softener (synthetic zeolite type) handling water of 15 grains hardness. Its exchange capacity is 480,000 grains, giving 32,000 gallons of soft water between regenerations. After being rebuilt by Elgin, the exchange capacity would be increased to 690,000 grains, giving 46,000 gallons of soft water between regenerations (44% increase).

Cost of 48" "Double-Check"* System	$156.40
Cost of added Synthetic Zeolite	114.00
	$270.40

This is a typical example of what can be done. The capacities of softeners using greensand zeolites can be increased in proportion to the exchange capacity of the zeolite. Other improvments we can provide are the Elgin Solo Valve (single valve control) and the Elgin Automatic Backwash Controller for accurate regulation of backwashing.

The Elgin representatives in your territory will be glad to give you complete information covering your specific conditions. Write.

ELGIN SOFTENER CORPORATION, 136 N. Grove Avenue, Elgin, Illinois

ELGIN BOILER WATER CONDITIONING PRODUCTS INCLUDE:

The Elgin Deconcentrator—makes boilers self-cleaning.

Continuous Blowdown Heat Exchangers.

Pressure sand filters and oil removal filters.

Individually prepared chemical treatments covering all needs.

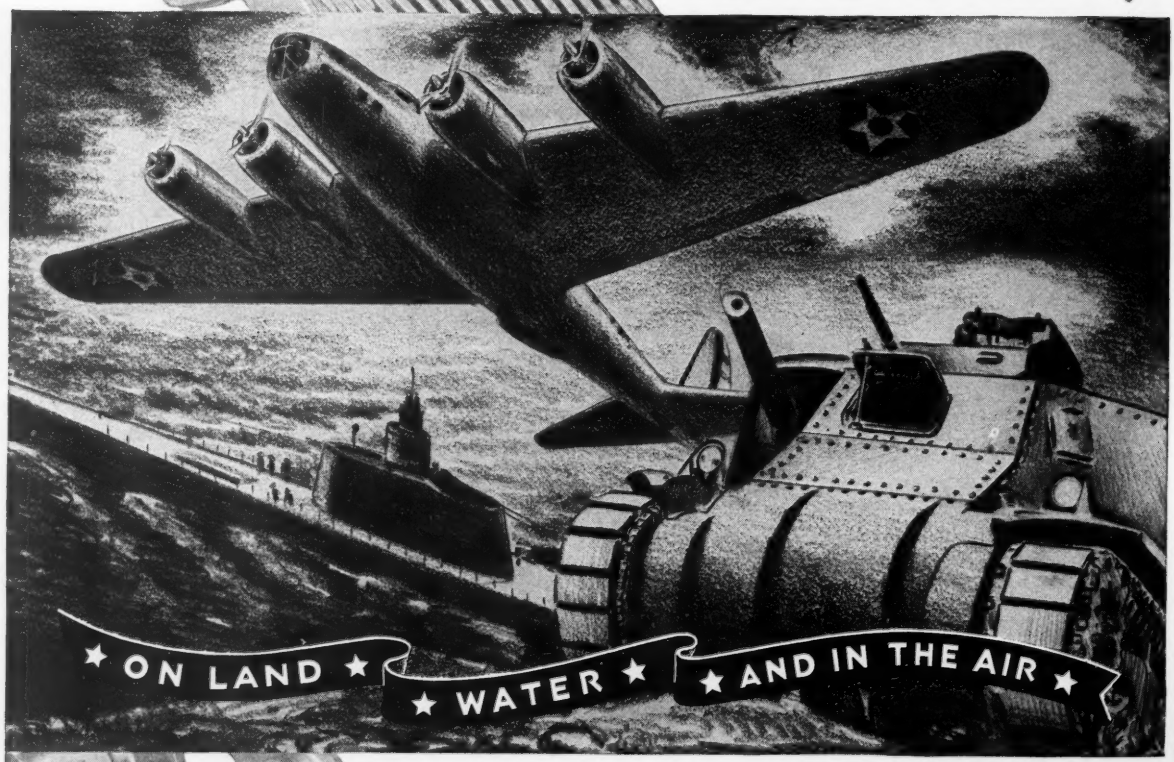
WRITE FOR BULLETINS

*** ELGIN "DOUBLE-CHECK" SYSTEM**

● It's an entirely different type of water distributing and collecting system, having ingenious double-check valves and strainer nozzles which permit the use of a far deeper zeolite bed and prevent zeolite loss. It further increases zeolite capacity by providing more efficient softening, backwashing and brining. All new Elgin "Double-Check" Type Water Softeners are equipped with this system.

ELGIN WATER CONDITIONING

Morse puts Teeth into Defense Equipment ★



IN DEFENSE EQUIPMENT—where the ultimate in power transmission is necessary—you'll find Morse Chain Drives on the job. In defense factories, too, Morse Drives are at work, transmitting all the power from drivers to working machinery efficiently and dependably. "Teeth, Not Tension"—no slippage—no power waste. They have the stamina to roll through overloads, shocks, moisture, dust and fumes without a falter. Investigate what Morse Chains can do for you—consult the Morse man in your territory.

SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS CLUTCHES

MORSE *positive* DRIVES

MORSE CHAIN COMPANY ITHACA N. Y. DIVISION BORG-WARNER CORP.

PLANT USES JUST 1/3 AS MUCH OIL WITH

STANDARD OIL STEAM CYLINDER OILS

● WITH THE LOAD on your power plant steadily increasing—with equipment operating longer hours—you are probably watching maintenance and lubricating costs climb steadily.

No doubt you're also looking for every opportunity to check these rising costs. Here's a suggestion. Standard Lubrication Engineers are equipped to make a complete lubrication survey of your power plant. They'll go over your operating records with you. Where costs seem out of line they'll have a suggestion to make. You get a complete, written report of these suggestions.

One survey in a Wisconsin state institution included the lubrication of three steam engines and a number of boiler feed pumps and steam operated water and fire pumps. When the Lubrication Engineer's recommendations were adopted, cylinder oil consumption dropped from 12 barrels a year to 4 barrels at this plant.

It costs you nothing to have one of these surveys made. Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago, Ill. Ask to have an Engineer explain just what he does in making a Lubrication Survey.

Copr. 1942, Standard Oil Company (Indiana)

STANDARD OIL COMPANY (INDIANA)

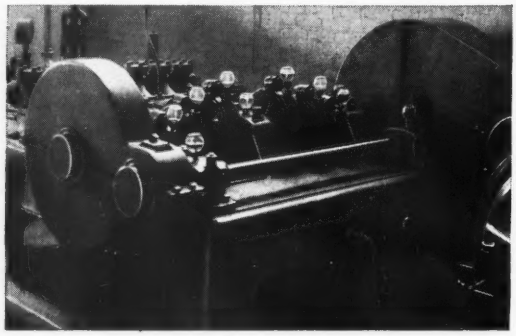
TION ENGINEERING...LUBRICATION ENGINEERING...LUBRICATION ENGINEERING...LUBRICATION ENGINEER

LUBRICATION ENGINEERING • • • LUBRICATION ENGINEERING • • • LUBRICATION ENGINEERING • • • LUBRICATION EN

USES ONE-FIFTH AS MUCH OIL . . . TAKES ONE-FIFTH THE TIME FOR APPLICATION

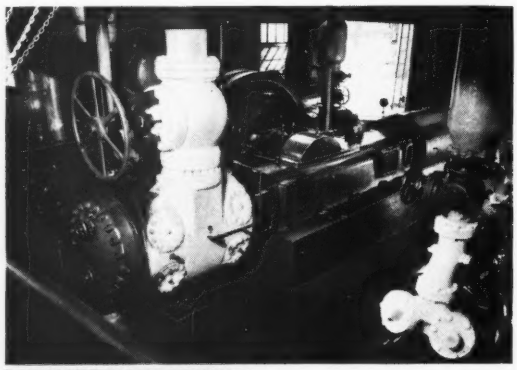
STANODRIP

The first gallon of Stanodrip tested in the bottle oilers on the homogenizer pictured below lasted 10 days. A gallon of the engine oil previously used had never lasted over two days. With no more trouble than it took to make this simple test, a Wisconsin manufacturer made an 80% cut in lubricating time and oil used on these machines.



The test was made when a Standard Oil Engineer was asked for his recommendation. He analyzed the operating conditions and picked Stanodrip, a high quality dripless oil, as the lubricant best fitted to meet them. The first gallon tested proved that Stanodrip would more than pay for itself in the oil and time it saved.

Let a Standard Oil Engineer test Stanodrip in some application in your plant.



STANOIL **PROVED IN**

24-HOUR SERVICE ON COMPRESSOR BEARINGS

Almost continuous operation, 24 hours a day, on an ammonia compressor in a Middle West packing plant gave Stanoil a severe two-year test.

Stanoil was used in the circulating system for bearing lubrication. After two years without bearing maintenance or lubricating difficulties of any kind, even under the severe operating conditions, there was no question about the oil to be used on a second unit being installed. Stanoil got the job. Test Stanoil yourself in a ring oiled bearing, speed reducer, or circulating system. See how it eliminates deposits that help cause bearing wear.

TIRED OF TRYING TO KEEP SMALL TURBINE OIL SYSTEMS CLEAN? TRY

NONPAREIL TURBINE OIL

Nonpareil Turbine Oil was developed to provide the safest possible lubrication for large, costly turbines operated by utility and industrial power plants. But it also offers operators of small turbines, such as the unit pictured above, a chance to eliminate considerable labor and maintenance.

Nonpareil has unusual stability against oxidation and sludge. That means the deposits which ordinarily collect in oil lines and gear cases on these units do not form with Nonpareil.

With a simple filter to remove foreign matter, and a small amount of make-up oil, all oil changes and oil system cleaning are eliminated.

Have a Standard Lubrication Engineer tell you why Nonpareil is the only oil with a written guarantee that *it will last as long as your turbine.*

• • •

WHY EXPERIMENT WITH LUBRICATION? SEE A STANDARD OIL ENGINEER FIRST!

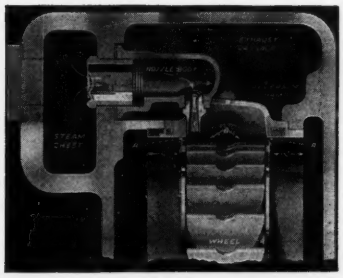
As you get less and less time to spend on operating details, many of these details are becoming more and more important. Lubrication is one of them. But it's one operating problem on which you can get real help.

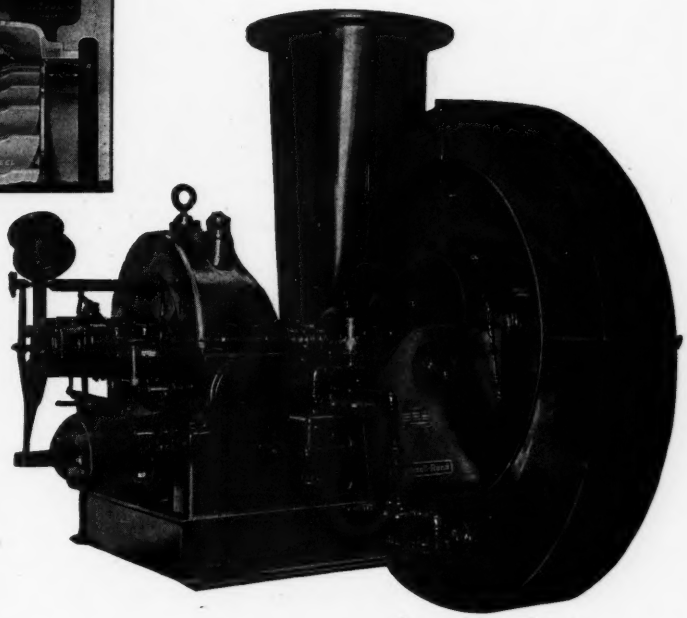
Instead of experimenting yourself with the new greases and oils to meet the higher speeds and heavier loads on power generating and transmission equipment, see the Standard Lubrication Engineer in your territory. He may have the answer to your problems right away. If he hasn't, you'll save time anyway, because he can call on the Standard Technical Service Department for help if it's needed.

Besides saving *your* time, you'll find that this Engineer's recommendations save lubricants, save machine time, save maintenance.

Just write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago, Illinois, for the engineer nearest you. In Nebraska, write Standard Oil Company of Nebraska at Omaha.

TERRY





ABOVE:
Terry Wheel Clearances. A-Rim Clearance. B-Large Blade Clearance. C-Side Clearance (about one inch)

AT RIGHT:
Typical Terry Solid Wheel Turbine direct connected to a blower.

THE BLADES ARE DOUBLE RIM PROTECTED
IN THE TERRY SOLID WHEEL TURBINE

In the Terry Turbine the blades have large clearances and are further protected by the projecting rims at the sides of the wheel. These rims would take without damage any rubbing that might occur if the radial clearance became reduced.

End play can do no damage to the blading as the side clearance is very large (about one inch). There is no end thrust since the steam enters and leaves the wheel in a direction at right angles to the shaft.

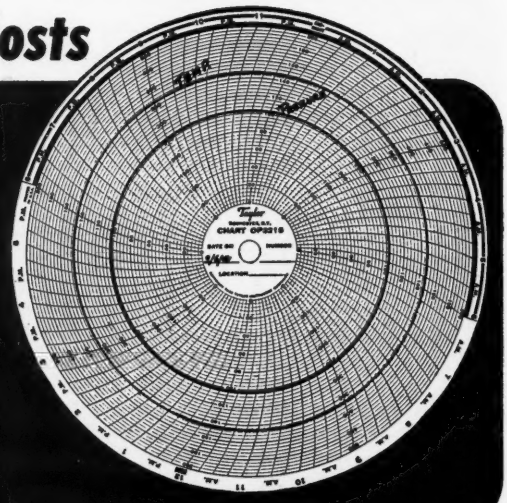
The Terry solid wheel turbine is described in our Bulletin S-116. A request on your business letterhead will bring a copy.

T-1146

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

Cut Spoilage and Operating Costs

Swartwout Reducing and Desuperheating Station automatically assures uniform control of process steam

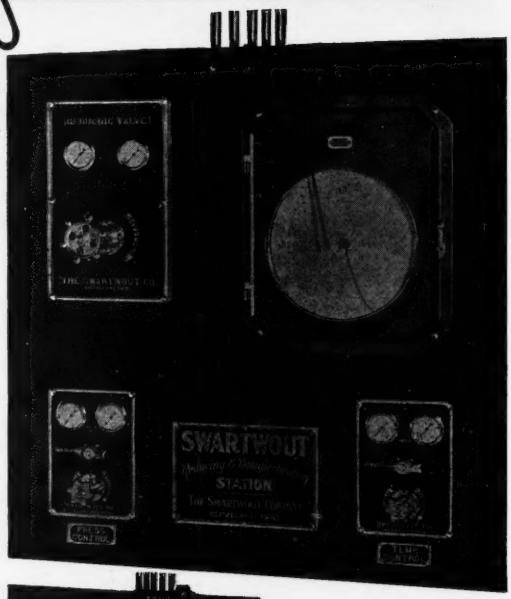


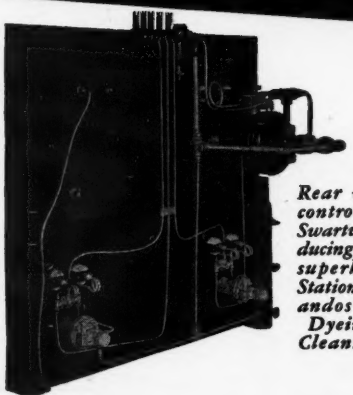
WHEN you want to be sure to hold pressure and temperature reduction "on the line" for important processes, plan for Swartwout Reducing and Desuperheating Control. Uniform results that spell economy and safety are achieved day after day in hundreds of plants by Swartwout Equipment.

The consistent performance recorded on the above chart means a great deal in time and money saved for Lewandos French Dyeing and Cleaning Company at Watertown, Mass. For wide variations in the quality of their process steam would mean costly spoilage and extra time for running work over. Their Swartwout R. and D. Station faithfully reduces steam from the high pressure to 105 lbs., 360° F., using a Type G Reducing Valve and Swartwout Carburetor Type Desuperheater.

Controls compactly grouped on the panel (at right) include Master Regulator for the Reducing Valve which can be readily set, manually; and manual controls for both pressure and temperature regulation. When set for a specific result, the station is completely automatic. Manual facilities provide convenient flexibility when desired.

When Swartwout assumes the *unit responsibility* of supplying properly related equipment, your entire problem of pressure and temperature reduction is solved with dependable guaranteed control. Swartwout design and painstaking manufacture—for 37 years—assure outstanding performance. *Write or phone for help on your steam control problems.*





Rear view of control panel, Swartwout Reducing and Desuperheating Station at Lewandos French Dyeing and Cleaning Co.

Feed Water Regulators • Pump Governors • Feed Water Heaters
Master Controls • Reducing Valves • Separators • Exhaust Heads

Swartwout
•Power Plant Equipment•

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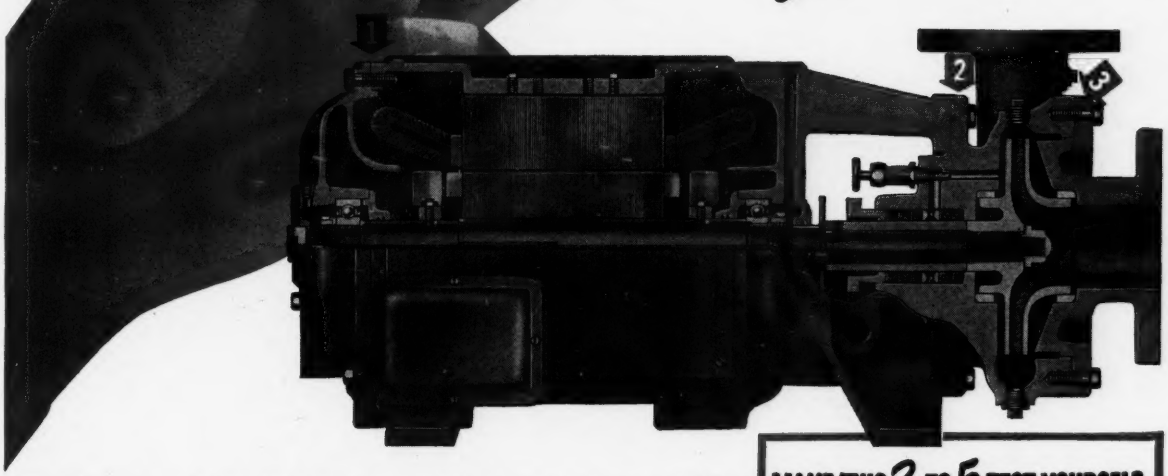
* * *

Controlled **AIR CIRCULATION**
for Power Plants and Industrial Buildings

THREE SECTION-FITS *Make Engineering News!*



Allis-Chalmers Electrifugal Pump Offers Exclusive "Tri-Fit" Design with One Piece Casting for Motor, Pump and Bearing Housing, Pump Bracket and Feet . . . Cuts Costs Up To 33%!

ANOTHER ENGINEERING SCOOP for Allis-Chalmers! A new, compact pump unit that offers you these outstanding improvements...

Unified "Tri-Fit" construction guarantees more positive alignment of the single shaft, less wear and tear . . . smoother running, vibration-free operation.

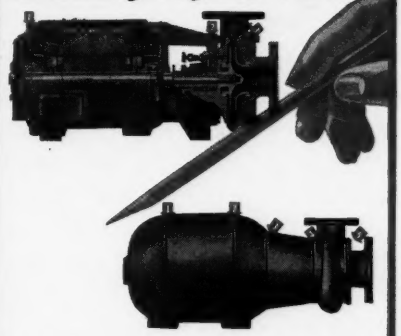
A new motor... 100% designed for pump drive and *completely splash-proof* . . . gives far more efficient power.

One-piece frame saves as much as 33% in space . . . 40% in overhang! Indestructible rotor and distortionless stator provide low maintenance and trouble-free service. Cast bronze protective sleeves, splash-proof ventilation and cast aluminum fans are other features that make this revolutionary pump such a great achievement in design and construction!

Best of all... *it cuts your costs up to 33% over conventional pump installations.*

For the money-saving details on this new "One Package" Pump... call the engineer in the district office near you. Or write Allis-Chalmers, Milwaukee, Wis. for Bulletin B-6140. A-1443

MAKE THIS 3 TO 5 TEST YOURSELF



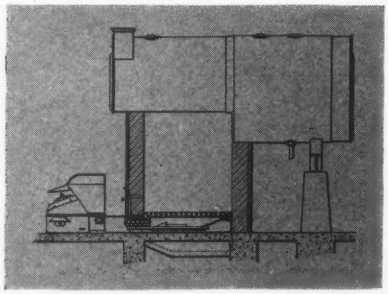
The NEW Allis-Chalmers Electrifugal Pump has only three section-fits compared to five or more for old style pumps! That means more perfect alignment of the shaft . . . less vibration . . . less wear . . . less trouble. Here's a pump that gives you more gallons . . . for less cost!

Allis-Chalmers Pumps Can Cut Your Pumping Costs

ALLIS-CHALMERS
MILWAUKEE · WISCONSIN

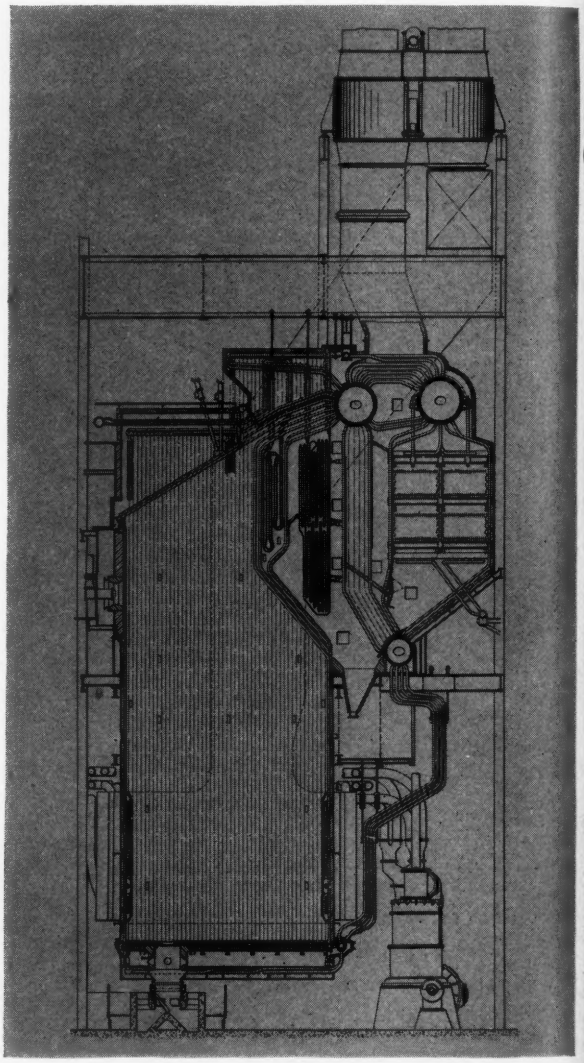
WHAT "INDUSTRY"

FOR CAPACITIES FROM 1,000 TO 1,000,000 LB OF



C-E PREMIER BOILER
C-E SKELLY STOKER
Capacity—1,000 lb per hr.

THIS group of actual installations, in general representative of recent purchases, can be viewed as a cross-section of present-day practice since C-E is supplying steam generating units for virtually every classification of industry. It shows how completely C-E equipment serves the complete range of steam capacities from 1,000 to 1,000,000 lb per hr. It indicates that C-E has an unusually comprehensive line of boiler and fuel-burning equipment. It has real significance for the man who shoulders the serious responsibility of selecting the right steam generating equipment for his plant. It suggests that, regardless of his problem, C-E has the widespread experience to help him determine the one best solution as well as the right equipment for his particular needs. A-634A



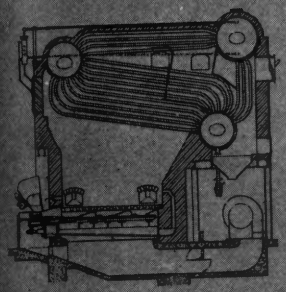
C-E CONTROLLED RADIANT BOILER
C-E PULVERIZED FUEL SYSTEM
Capacity—1,000,000 lb per hr. Design
Press.—1,800 lb. Steam Temp.—955° F.

C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS, AND AIR HEATE

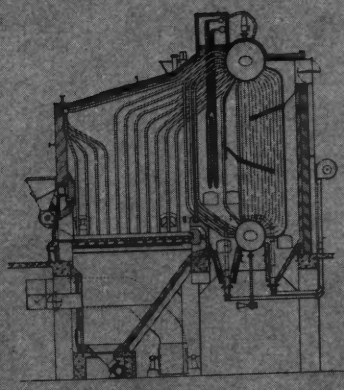
COMBUSTION

IS USING TODAY!

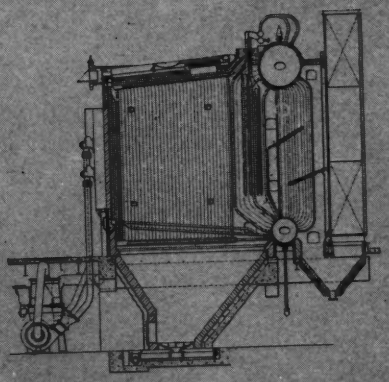
STEAM PER HR



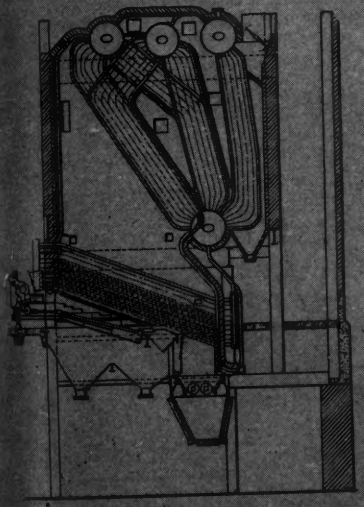
C-E TYPE VM BOILER
C-E TYPE E STOKER
Capacity—23,000 lb per hr.
Design Press.—275 lb.



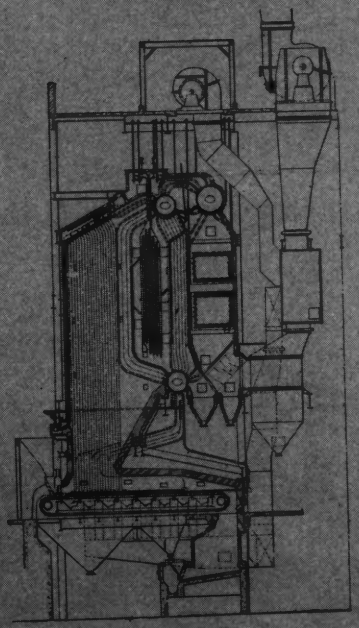
C-E TYPE VU-Z BOILER
C-E SPREADER STOKER
Capacity—38,800 lb per hr. Design
Press.—275 lb. Steam Temp.—505° F.



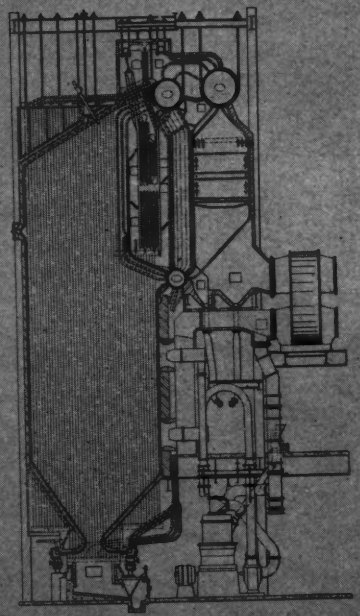
C-E VU STEAM GENERATOR
C-E PULVERIZED FUEL SYSTEM
Capacity—70,000 lb per hr. Design
Press.—450 lb. Steam Temp.—625° F.



C-E TYPE VA BOILER
C-E MULTIPLE RETORT STOKER
Capacity—90,000 lb per hr. Design
Press.—200 lb. Steam Temp.—371° F.



C-E TYPE VE BOILER
C-E TRAVELING GRATE STOKER
Capacity—185,000 lb per hr. Design
Press.—1,425 lb. Steam Temp.—930° F.



C-E TYPE VE BOILER
C-E PULVERIZED FUEL SYSTEM
Capacity—285,000 lb per hr. Design
Press.—1,450 lb. Steam Temp.—915° F.

COMBUSTION ENGINEERING COMPANY, INC., 200 MADISON AVENUE, NEW YORK, N.Y. • CANADA: COMBUSTION ENGINEERING CORPORATION, LTD., MONTREAL

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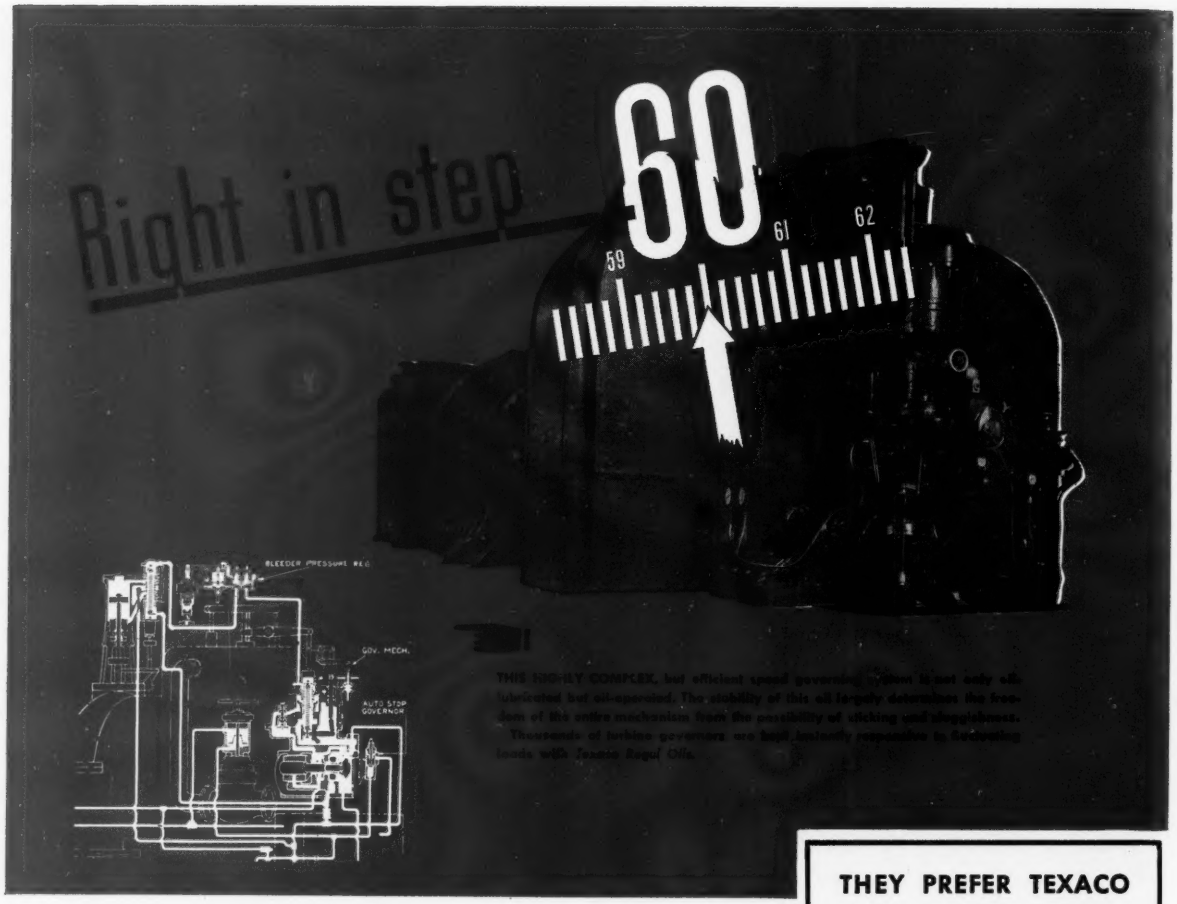

YOUR GOVERNORS WILL function efficiently, keeping turbo-generators at the correct speed, regardless of load, when they are lubricated with *Texaco Regal Oils.*

Texaco Regal Oils separate rapidly from air and water, are highly resistant to oxidation, emulsification, gum formation, and sludging.

The outstanding performance that has made Texaco preferred in the fields listed in the panel has made it preferred by operators of thousands of turbines everywhere.

These Texaco users enjoy many benefits that can also be yours. A Texaco Lubrication Engineer will gladly cooperate . . . just phone the nearest of more than 2300 Texaco distribution points in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York, N. Y.

THEY PREFER TEXACO

★ More Diesel horsepower on streamlined trains in the U. S. is lubricated with Texaco than with all other brands combined.

★ More locomotives and cars in the U. S. are lubricated with Texaco than with any other brand.

★ More revenue airline miles in the U. S. are flown with Texaco than with any other brand.

★ More buses, more bus lines and more bus-miles are lubricated with Texaco than with any other brand.

★ More stationary Diesel horsepower in the U. S. is lubricated with Texaco than with any other brand.

FOR YOUR ENJOYMENT
TWO GREAT RADIO PROGRAMS

FRED ALLEN every Wednesday night. See your local newspaper for time and station.

METROPOLITAN OPERA. Complete broadcasts of great operas every Saturday. See your local newspaper for time and station.

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FOR ALL TURBINES

RETURN METAL DRUMS PROMPTLY . . . thus helping to make present supply meet industry's needs and releasing metal for War Needs.

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POWER PLANT ENGINEERING

FEBRUARY, 1942
VOLUME 46, No. 2

Cover: The illustration shows an example of the vital part power supply plays in speeding the output of essential war equipment. Here we see electric welding and grinding jobs being done simultaneously to quicken army tank production. The power department is responsible for the ample, continuous flow of power for war production. Acme photo.

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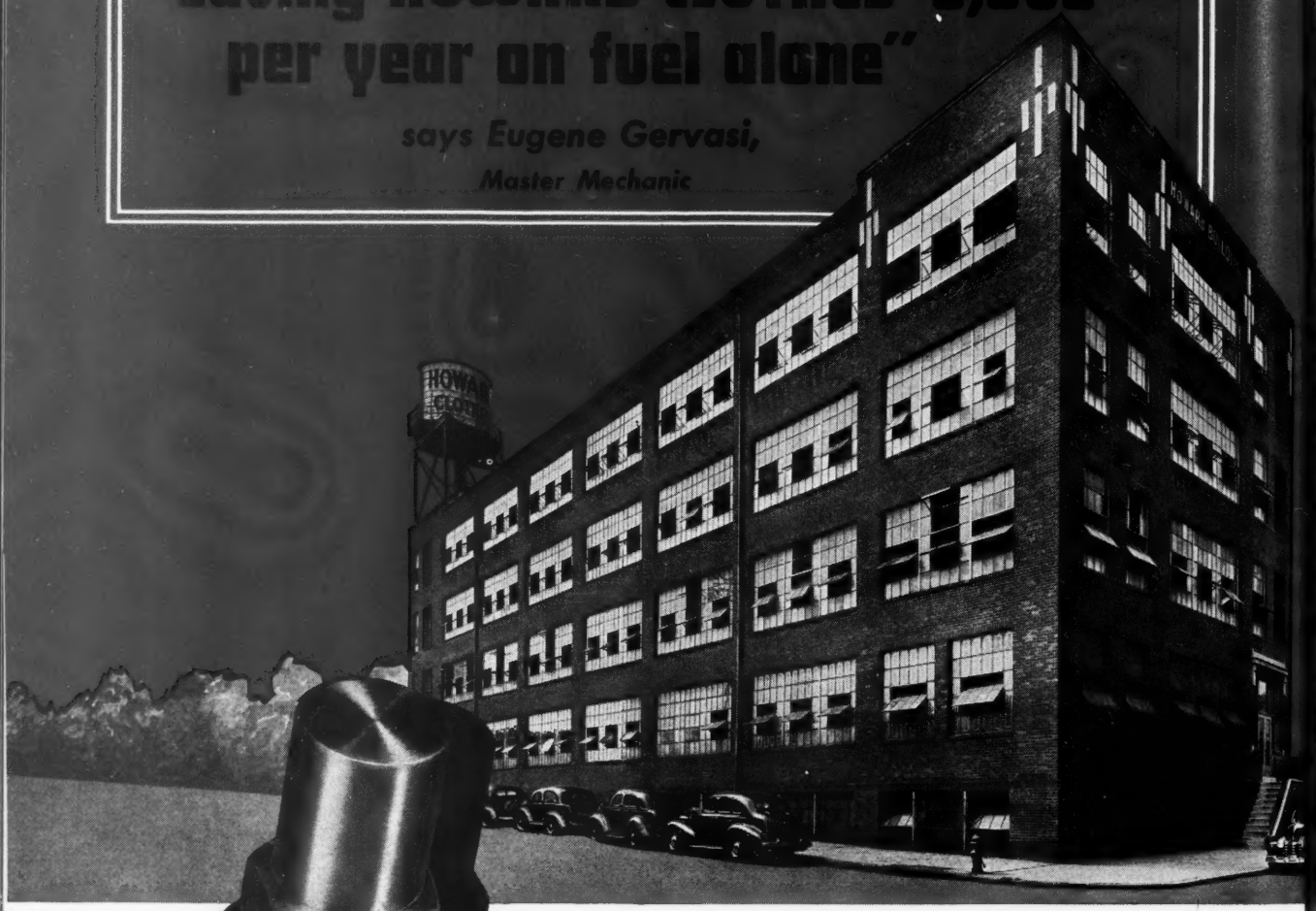
"YARWAY TRAPS are saving HOWARD CLOTHES $3,000.00 per year on fuel alone"

says *Eugene Gervasi,*
Master Mechanic



MORE than 100 Yarway Impulse Steam Traps are serving Howard Manufacturing Company's Philadelphia Plant where the famous "Howard Clothes" are made.

Draining steam lines, headers, steam separators and pressing machines of various types—these traps speed-up "heat-up," keep equipment hot, assist in the big job of turning out approximately 150,000 suits per year.

And last, but not least, these Yarway Traps are "saving Howard Clothes $3,000.00 per year in fuel oil."

Why don't you install a Yarway Impulse Trap or two and let them prove what they can do for you? See how its *small size saves space.* How its *light weight* and *straight through piping* make installation easy. How its unique design, with *only one moving part,* and its rugged *bar-stock construction,* cut maintenance costs. Then too, there is *no need to change valve or seat for widely-varying pressures.*

And when you consider that *their purchase is usually no more than the cost of repairing an ordinary trap*—why not get Yarway performance for your money?

A nearby Mill Supply Dealer handles Yarway Traps and will be glad to serve you. Or write for Catalog T-1736.

YARNALL-WARING CO., 114 Mermaid Ave., Phila., Pa.

YARWAY IMPULSE STEAM TRAP

WHAT LEADERS SAY

Industry Salutes - And Answers the Call

By WILLIAM P. WITHEROW

ARISTOPHANES said: "Lightnings and thunders from his mouth he hurled, and made a chaos of the Grecian world." Today we have another whose lightnings and thunders destroy and reverberate throughout ALL the world, and, drunk with power and thirsty for more lands to ravish, he has cast his eyes upon new horizons, to the rich, prosperous and happy Democracies beyond the sea.

America, slow to anger, has awakened . . . dispatched the S.O.S. to American industry . . . industry salutes and answers the call. Lincoln, in an earlier American emergency, said: "If we do not make common cause to save the good old ship of the Union on this voyage, nobody will have a chance to pilot her on another voyage."

"Common cause" means teamwork which is as vital to success here as in football. All elements must function together; the quarterback must call clear, understandable and intelligent signals; the captain formulates the type of play; the team, working in close harmony, carries out the plan. The captain and quarterback in this homely simile may be compared to the government, the line and the backfield are the workers and managers. The closer the unity, the surer no one will block the kick, nor intercept the pass.

Most important, all should understand in our present emergency "things as usual" cannot obtain. Industry is now engaged in the production of schedules already fantastic in their scope, astronomical in their degree—future schedules will be superfantastic and super-astronomical. American industry, reared in a system of economy, founded on hard work, sacrifice, skill, resourcefulness and ingenuity, can and will meet the demands of the day. Industry in its larger sense, employer and employe alike, can answer the signal and face the stupendous challenge hurled at it.

Our industry is strong and capable of assuming the critical task before us. Let us keep it strong and let it grow to even greater stature. Let us sacrifice and bear all the necessary burden to carry this job through, but let government in turn keep a steady eye upon the fundamentals of American life, the freedom of action, speech, worship, assembly, and last but not least, free enterprise—the cornerstone of them all.

Operation of our industrial structure may be compared to the operation of our Army. (It takes eighteen soldiers behind the lines for one at the front; in the last War, the ratio was four to one.) We have both military and industrial soldiers; we have both military and industrial officers; and in each case, we all have the same boss—that is "Uncle Sam" himself. Each is working with fervor for defense. Worker is no less gallant than the soldier; the manager is no less patriotic than the officer; all are working for the same goal.

Industry recognizes the vast complexities, rearrangements and readjustments so necessary in the conversion from a peacetime to a wartime basis. Its ingenuity is amply illustrated in the manner in which plants formerly making civilian goods have switched to military production. Plants have shifted from typewriters to machine guns—sewing machines to pistols—lawn mowers to shells—refrigerators to artillery—tin cans to gas masks—ash trays to airplane parts—vacuum cleaners to bomber parts—piccolos to gun barrels.

In this great effort, it is not in any way the function of industry to determine the areas of defense or the tools to prosecute it. It is industry's sole function to forge the tools and furnish them upon governmental demand. We should, however, think in terms of needs, rather than of wants. Industry will produce what is needed; it is doubtful whether it can furnish what everyone wants.

There must be no faltering by any group for we know what has happened to nations which have faltered, but we should have perfect frankness as to the real situation confronting the nation, exaggeration should be avoided, people should not be needlessly aroused, and at the same time, there should not be a false lulling of security which does not exist. All the people, including management, labor and government, should subordinate their wants as distinguished from their needs in this critical hour.

Our ears are attuned to the clarion call of our forefathers: "We provided your liberty; safeguard it to the end. Treasure your freedom as your most precious heritage and defend it until death. America owns a spiritual birth. Let your faith in God endure."

American unity over the past century has not failed. Neither will there be any weakening in the present crisis. The industrial structure of the United States stands pre-eminent in its devotion to its obligations and its privileges to salute the flag and carry on.

WILLIAM P. WITHEROW, president of Blaw-Knox Co. and recently elected president of the National Association of Manufacturers, graduated from Yale in 1908; worked for Jones & Laughlin Steel Corp., established his own engineering firm in 1910 and organized the Witherow Steel Co. in 1913 and served as its president. Witherow Steel purchased the Dilworth Porter Co. in 1927 and merged with the Donner Steel Co. in 1929 with Mr. Witherow Chairman of the Board. After consolidation with Republic Steel in 1930, Mr. Witherow served as vice-president until his resignation in 1932.

He was then successively: Chairman of the Pittsburgh Committee of the N.I.R.A.; resident director of the N.I.A.B.; director of the N.I.R.B.; and in 1936 attended the International Labor Conference in Geneva as technical adviser representing the steel and coal industries. He was elected president of Blaw-Knox Co. in 1937. During 1940 he was chairman of the Industrial Mobilization Committee of the N.A.M.

The address from which this page was taken was delivered at the 46th Annual Convention of the Association in New York on December 3, four days before war began. His foresight and keen appraisal of the situation is apparent for his remarks are even more appropriate for the Victory Program than for the Defense Program. Much of the address omitted here for lack of space dealt with specific suggestions for closer co-operation.

MIKE and IKE —They Look Alike

DON'T be alarmed, ladies and gentlemen and little children—these funny looking men won't hurt you. They did not come from Mars nor have they anything to do with Orson Welles, and those things in their hands are not bloody bayonets. They are merely a couple of operators at the Duquesne Light Company's Dravosburg Substation dressed in special safety equipment as they use voltage detector sticks on a 22,000 volt line. It pays to be careful in the care and operation of high voltage equipment. Whenever parts of the system have to be disconnected for service or repair, tests must be made to determine whether the voltage is "off" before opening disconnects. Dressed in rubber suits and gloves and with heavy fireproof masks these operators are as safe as human ingenuity can make them for fulfilling their hazardous work. We are still wondering whether they can eat.

WITH THE EDITORS

◆IN WASHINGTON . . . A month after war was declared the increased tempo of production was noticeable although the full implication of the task ahead seemed apparent only to the Executive Offices and to the OPM. In his message of January 7, the President set as the Nation's goal—and admits no doubt that it will be reached—as: 60,000 airplanes, 45,000 tanks, 20,000 anti-aircraft guns, and 8,000,000 t. of shipping for 1942; and 125,000 airplanes, 75,000 tanks, 35,000 a.a. guns and 10,000,000 t. of shipping in 1943.

◆OPM's PROBLEM . . . To carry out this program regardless of cost in money, men, effort and materials, was at the time the direct responsibility of OPM. Given the breaks, consummation on schedule was definitely "probable" with the shipbuilding program in the most strategic position. The bottleneck, constantly growing more constricted due to the war in the East, is still materials, roughly, with metals in the order of their importance as: magnesium; aluminum; nickel; tin; copper; zinc; lead; iron and steel. To this list, in an indefinite position, must be added rubber.

The breaks will depend largely upon continued and increasing authority to get tough and push on production regardless of where the shoe pinches; the further development of substitute materials; and revision of specifications by the armed forces and industry permitting the use of substitute materials, so as to give, not the best possible product, but the minimum necessary to do the job in hand; much further coordination of all purchasing agencies to prevent internal competition and duplication of effort; and, perhaps most important, a unanimous realization that winning the war is the country's Number 1 problem, superseding the rights, privileges and needs of individuals, or specific groups. These privileges are predicated upon the continued existence of the Nation, and a form of government, dedicated to the prime needs of the majority.

◆JUNKING THE SPAB . . . This was an advance toward the simplification and centralized authority long demanded by industry and the World War I production "czar" Bernard Baruch. In keeping with the times the new organization head, Donald Nelson, is popularly termed the "dictator". In a few weeks as head of SPAB he demonstrated his ability to administer without fear or favor, and it is said he was allowed by the President to write his own ticket outlining the authority deemed essential to execution of the task.

As chairman of the WPB Mr. Nelson has supreme authority to: exercise general direction over the war procurement program; determine policies, plans, procedures and methods of the several federal departments; exercise the powers vested in the old SPAB; as well as supervise, and make such changes in organization of the OPM as he deems necessary.

◆THE PROBLEM TWINS . . . Civilian Defense and Price Control, both admirable in themselves, offer grave difficulties in carrying out orderly prosecution of the war effort. Two or three flashlights, shovels and two buckets per household are questionable in the light of present zinc shortages (for batteries) and the fact that there is considerable question as to whether sufficient metal (black sheet not alone tin plate) will be available for food containers.

Price control measures are dangerously involved in politics, tightly wedged between various pressure groups, a Congress with an eye on coming elections and the administration's attempts to weave prices, taxation and war financing into a reasonably effective halter on inflation. On the surface administration policy seems no more definite or logical than the action of Congress, and perhaps extends no farther than authorization to meet unknown future problems as they arise in the way that seems best at the time.

At the time this is written, the House and Senate seem well on the road to compromise, on their conflicting price control bills, through a system of business licensing, although the details and probable effectiveness of the measures are yet in doubt.

◆FINANCING . . . The war is currently no problem for "No war was ever won in the counting house." The problem or problems of financing such astronomical figures is primarily in connection with the control of inflation and the prevention of post war economic disturbances.

Inflation increases war costs, throws an undue burden on the working class because living costs outdistance wage increases, and depreciates the value of savings. A much larger proportion of war costs will be financed by current taxation than ever before and may reach 40 per cent.

The remaining 60 per cent must be borrowed and it is in this connection that the defense bond and stamp sales are so important. Money borrowed by the government from banks is undesirable for two reasons. First, it tends toward inflation in itself by creating new money which the banks can issue against the new bonds. Second, it builds up a group of post war bond holders separate and distinct from the main body of taxpayers.

◆DEFENSE BONDS . . . Sales of bonds direct to the taxpayers on the other hand creates no new money but makes use of that already in circulation. Furthermore the debtor and creditor are one and the same. For purpose of illustration assume that all taxpayers are all individuals and all pay the same tax at a flat rate. In addition they each buy a proportionate share of defense bonds necessary to finance the balance of the current war program.

At the end of the war each taxpayer is responsible for his share of the bonded debt but he holds bonds to cover his tax responsibility. That is he pays his taxes to pay himself for the bonds he holds. In effect the war was financed by current revenue. Simple? Too simple. Last month the sale of defense bonds and stamps ran between five and six billion dollars or perhaps a fifth of the necessary amount. If the war is extended some form of forced saving may well be expected in order to broaden the base and prevent serious post war disturbances from the tremendous wartime debt which certainly will not be less than 100 billion dollars and may well be more.

◆PLANT PROTECTION . . . This remains the primary responsibility of individual plants and manufacturers for maximum production is essential at all times. In addition to regular fire and accident prevention campaigns, plant protection should be provided and this can be divided into two main headings: protection against deliberate sabotage; and protection against air raid damage.

Power plants of all kinds are divided into three broad classifications each taken care of by a different government agency. First are utility plants directly concerned with defense work. These are the responsibility of the Federal Power Commission who will recommend steps to be taken by individual plants. They will also co-operate, when requested, with other utility plants not directly concerned with defense work.

Second, are industrial power plants operated by companies doing war work for the Army and Navy. These come directly under the FBI as a part of the entire manufacturing plant.

Third, there are a large group of institutional and service institutions not directly connected with armament production yet vital to the welfare of the Nation. Help and assistance for these plants will be rendered by the Office of Civilian Defense.

While the exact status of articles and information of this kind is not yet known, it appears that magazines will be allowed to print very little in the way of specific details for plant protection. Therefore, it is necessary for each plant to get in touch with the proper authorities to be sure that every precaution deemed necessary is made and that steps be taken to insure continuity of operation during emergencies.

POWER AND ELECTRICAL

A brief summary of the year's more important developments in the electrical industry of specific interest to those in the power industry. Aside from many spectacular developments in the stationary power field an unusual development was the construction of two 10,000-kw. mobile steam electric power plants for the United States Navy for emergency use

NOTHING so forcefully reflects the great scope and development of the electrical industry during 1941 than the graph showing the monthly sales of electricity to industrial plants during the year as compared with those of other years. This graph is shown in Fig. 4. It will be noted that the sales rose from a level of around 5½ billions of kw-hr. per mo. at the beginning of 1941 to over 7¼ billion kw-hr. in October, and the curve is still rising steeply.

This increase in the sale of power to industry is, of course, not unexpected in view of the tremendous increase in our industrial production as a consequence of our war effort. According to Leland Olds, Chairman of the Federal Power Commission, every dollar of Defense-power spending requires 2¾ kw-hr. of electrical energy.

In the central station field the great increase in demand for industrial power during the year was met successfully in every section of the country except for a few weeks in the Southeast where extreme drought made necessary the temporary curtailment of non-defense power uses. Due to shortage of material, to other defense demands on manufacturers of turbines and to labor difficulties, generating capacity actually installed by the utilities in 1941, fell 600,000-kw. behind installation programs. Peak loads increased 3,250,000-kw. during the year. Net additions to generating capacity amounted to 2,712,000-kw. or 538,000-kw. less than the increase in peak loads, drawing to that small extent on reserves.

Installed capacity at the end of the year, as reported by the Edison Electric Institute, was 9,600,000-kw. in excess of the sum of the individual peak loads, compared with a margin of 10,150,000-kw. in 1940.

The electrical industry stood out prominently not only in its very substantial direct contributions to the war program but it was also called upon to help all the other industries in gearing their facilities to such production—to supply more power-generating equipment, more motors, more controls, new electric heating processes, new welding technique, special electronic tube devices, and equipment and methods for in-

Fig. 1. (Below) A row of 60-in., 800,000,000 candlepower searchlights ready to leave the General Electric Co. shops

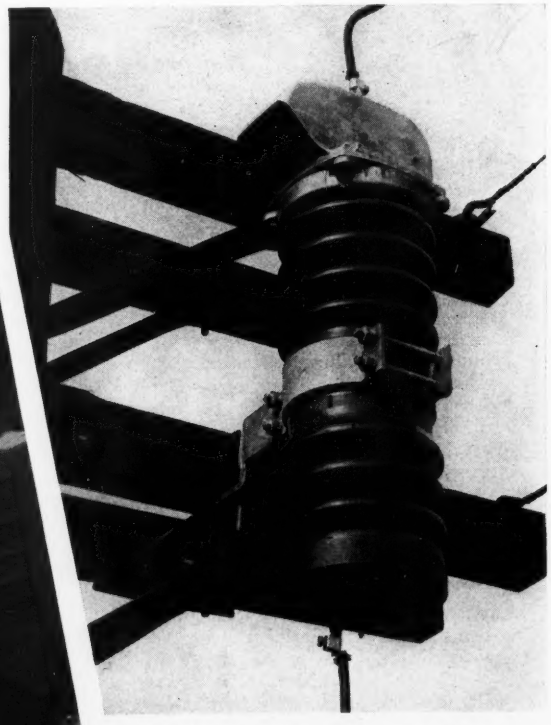


Fig. 2. (Above) Quality service on rural lines will be improved by this Westinghouse automatically reclosing oil circuit breaker designed for mounting of pole cross arms

DEVELOPMENTS IN 1941

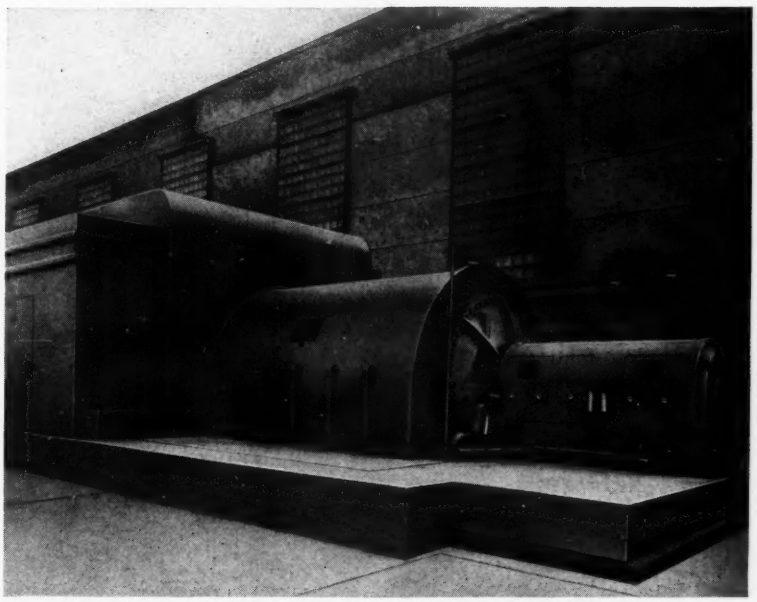


Fig. 3. General Electric outdoor steam turbine-generator set with hydrogen-cooled generator rated at 20,000-kw. at the City of Glendale (Calif.) power station

creasing the power carrying capacity of distribution systems already carrying full loads.

Before the end of the year, companies like the General Electric Co. and Westinghouse, were devoting from ½ to ⅔ of their productive facilities to war items. Some of the plants of these companies were engaged almost entirely this way.

Electrical engineers were called upon during the year for many unusual and highly specialized designs of all sorts of products. They responded promptly and efficiently, and in the future the results of their endeavors will be reflected in still other fields.

While it is impossible in the limited space available to present a detailed account of even those developments of direct interest to the power industry, a good general impression may be had from the following abstracts of the engineering achievements of the three great electrical companies in this country.

GENERAL ELECTRIC CO. DEVELOPMENTS IN 1941

As reported by the General Electric Co., statistics concerning 56 turbine-generator sets of 10,000-kw. or greater capacity, aggregating 2,339,000-kw. for public utility service, reveal interesting trends concerning size, operating conditions, etc. The average capacity for the entire list is 41,600-kw., and all but two—one of 25,000-kw. and one of 15,000-kw. are for condensing service; a fact indicating the effect of national-defense power requirements. Eleven, single cylinder turbines ranging from 50,000 to 80,000-kw. are designed for operation at 1800 r.p.m. There are five 85,000-kw. cross-compound sets with high-pressure elements at 3600 r.p.m. and low pressure elements at 1800 r.p.m. Forty machines, totaling 1,194,000-kw. are for operation at 3600 r.p.m. The two-speed cross-compound machines divide into two groups, with 16 generators totaling 917,000-kw. at 1800 r.p.m., and 45, totaling 1,422,000-kw. at 3600 r.p.m. Six high-speed, high-pressure casings have double shell construction. Twenty turbines, in sizes from 25,000 to 60,000-kw., are of the close-coupled, tandem-compound construction with fabricated double flow exhaust casings.

Ten of the turbines will operate at 1200- to 1350-lb. pressure; 25 will be in the range from 800 to 875 lb.; 12 are for 600 to 650; 8 are for 300 to 450; and one low-pressure element with an entering cross-over pressure of 195 lb.

Among the 3600 r.p.m. units all rated above 25,000-kw. and all but one rated 25,000-kw. will have hydrogen cooling. The three 80,000-kw. 1800 r.p.m. generators will also be hydrogen cooled, as will be both high- and low-speed generators of the five cross-compound machines.

Twin Branch Turbine

Most outstanding of all the turbines delivered or placed in service during the year was the one placed in use in the Twin Branch Station of the Indiana and Michigan Electric Co. The performance of this unit surpasses that of any other installation in the United States from the standpoint of the economy that is expected of it. It is a cross-compound unit with an aggregate rating of 76,500-kw., designed to use steam at an initial pressure of 2300 lb. per sq. in., the highest ever used in an electric utility generating station in this country.

The second 80,000-kw., 1800 r.p.m. single-casing turbine with hydrogen-cooled generator for the Central New York Power Corp., was placed in service at Oswego, N. Y. Another noteworthy installation of the year was the 80,000-kw., 1800 r.p.m. single-casing machine at the Buck Station of the Duke Power Co. The first hydrogen-cooled turbine-generator for outdoor operation was placed in service by the City of Glendale, California. Rated at 20,000-kw.,

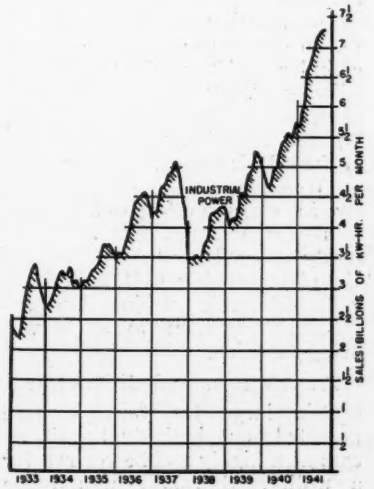


Fig. 4. Sales of electricity to industrial plants

the turbine has an unusual load characteristic to give it very efficient performance at light loads.

An unusual development is the construction by G. E. of two 10,000-kw. mobile steam electric power plants mounted on special railway cars, for The Navy Department to supply emergency power wherever its projects may require. Each power plant is housed in two specially built railway cars. The boiler and its auxiliaries, and a starting engine generating set have one car; the turbine-generator and its accessories, a condenser, and switchgear have the second. A mobile substation constructed on a standard car will also be used to permit proper voltage to be obtained for any Naval Shore Establishment.

Each unit will furnish 140,000 lb. of steam per hr. The single-cylinder turbines will use 550-lb., 825 deg. F. steam. The 3600-r.p.m. generators produce 60-cycle, 3-phase, 13,800-v. power, and will be forced air cooled.

Well over a million kv-a. capacity in waterwheel-driven generators was under construction or newly ordered at General Electric Co. plants during 1941, and about 9,000,000-hp. in turbines for propulsion equipment in ships was being supplied.

Transformers and Switchgear

Six large transformers were mounted on individual railway cars as a highly mobile reserve for a utility. Spirakore wound-core construction was extended to distribution transformers in the 22,000 to 66,000 v. range, and a new form of shielded-layer winding provided for the 44,000 to 66,000 v. ratings. Load ratio control equipment was extended to ratings up to 50,000 kv-a. and 220,000 v.

Metal-clad switchgear was developed for the 250,000 kv-a. G. E. magne-blast circuit breaker. A new type of a.c. generator speed-matching and paralleling equipment was developed and applied for automatic hydroelectric stations. For control of the Smith-Putnam wind turbine at Grandpa's Knob, Vt., the switchgear is something like that for an automatic hydro-electric generating station, but it also includes equipment for the accurate control of the wind turbine by adjustment of the turbine blades.

A new single circuit substation unit was developed to provide in one co-ordinated and factory-built assembly, a complete outdoor-type substation with one outgoing feeder. A complete line of load center unit substations for secondary voltages of 600 v. and below was developed to meet the needs for electric power at utilization voltage, and was quickly adopted in a wide variety of industries.

Instruments

A new principle of insulation construction was applied to outdoor current transformers, 7.5 and 15 kv. 1000 amp. and above. Medium-size inkless recording ammeters and voltmeters were made available with a 30 in. chart moving at the rate of one inch per day. A line of 9600-cycle instruments was made available particularly for induction heating service. A new photoelectric recorder, featuring unit construction, was given a response speed five times as fast as the previous design. The writing speed of the oscillograph electric transient analyzer was doubled by the use of a higher cathode-tube voltage. Electromagnetic strain gages were applied to give a continuous indication of strain in vital parts of machine tools. A travel or displacement recorder, a scrape abrasion tester for synthetic wire enamels, a short interval chronoscope, a thermal-conductivity-type gas analyzer, and an all-electronic spark generator for spectrographic

Fig. 5. (Above) This 3600 r.p.m. hydrogen-cooled, Westinghouse generating unit is installed at the Acme Station of the Toledo Edison Co. It is rated at 62,500 kv-a.

Fig. 6. (Right) The 20,000,000-v. Rheotron, giving electrons a speed within 1/10 of 1 per cent of that of light in the G.E. laboratories

analysis were still other new instruments of the year.

The General Electric Tri-Clad motor line was extended in both size and variety. Now included are both open and splashproof constructions, with mechanical modifications as round frame, face- and flange-type end shields, vertical motors, and gear motors.

Wound rotor polyphase induction motors were built with 1500-hp. ratings; the largest of such type had been 800-hp. Another record for size was set by a 3000-hp., 1800 r.p.m. squirrel cage polyphase induction motor.

A new blue-sensitive phototube developed by General Electric possesses about 30 times the quantum efficiency of the red sensitive types. The manufacturing technique used in making tubes was applied advantageously to vacuum capacitors and a high vacuum switch.

WESTINGHOUSE ENGINEERING ACHIEVEMENTS IN 1941

At its East Pittsburgh works, The Westinghouse Electric & Mfg. Co., during 1941, increased by 70 per cent its production of electric generating equipment. The generator division completed and installed the first of the three largest waterwheel generators in the world—the 108,000-kw. machines built for Grand Coulee. Westinghouse also received during 1941 an order for three more of these generators to be installed at Grand Coulee during 1943 and 1944.

The list of Westinghouse steam turbines for 1941 shows a wide variety of types. The majority, as might be expected, operate at 3600 r.p.m., although here the record of generator size set last year—Consolidated Edison Company's 65,000-kw.—is only modestly exceeded. Only four of 37 units, or 17 of the total rating, run at 1800. For units up to about 60,000-kw.—the bulk of the machines built—the 1800 has been virtually abandoned. The 1800 r.p.m. machine has, however, by no means been eclipsed by higher speeds for the top capacities. Notably, there is the 80,000-kw. single-cylinder unit for the Chester Station of the Philadelphia Electric Co. This has a low inlet pressure, 250 lb., and on this account is extremely large physically. There are several tandem units, displaying a wide variety of combinations of speed and arrangement. For instance, the 100,000-kw. condensing turbine for the Burlington Station of the Public Service Electric and Gas Co. is what might be termed a cross-compound tandem machine. A high-pressure (1250 lb., 950 deg.) unit drives a 50,000-kw. generator. It exhausts to two low-pressure tandem units, coupled to a 50,000-kw. generator. Both shafts turn at 3600 r.p.m.

On the other hand, in each of the two cross-compound 150,000-kw. units for the Southwark Station, Philadelphia, one turbine drives a 65,000-kw. generator at 3600 r.p.m., while a low-pressure turbine turns an 85,000-kw. generator at 1800 r.p.m. The third 150,000-kw. unit, for the Commonwealth Edison Company's Fisk Station, made up of a two-cylinder tandem turbine unit and a single 1800 r.p.m. generator. Hydrogen cooling has virtually swept the field for all generators above 20,000-kw.

It is significant, and at the same time a tribute to modern design, that although the demands have been great and the types many, few important changes in basic construction have been required. Several years ago turbine designers realized that standardization of complete units, for all its attractiveness, was not for them. Seldom, if ever, would two turbines of similar rating of 25,000-kw. or larger be exactly alike. They did the next best thing, however, which has proved a boon in the present times. They developed a family of designs for the complete range of sizes, each one related to the next in basic form and principle. Only through correlated lines of similar parts regardless of machine size could the present demand for machines be met.

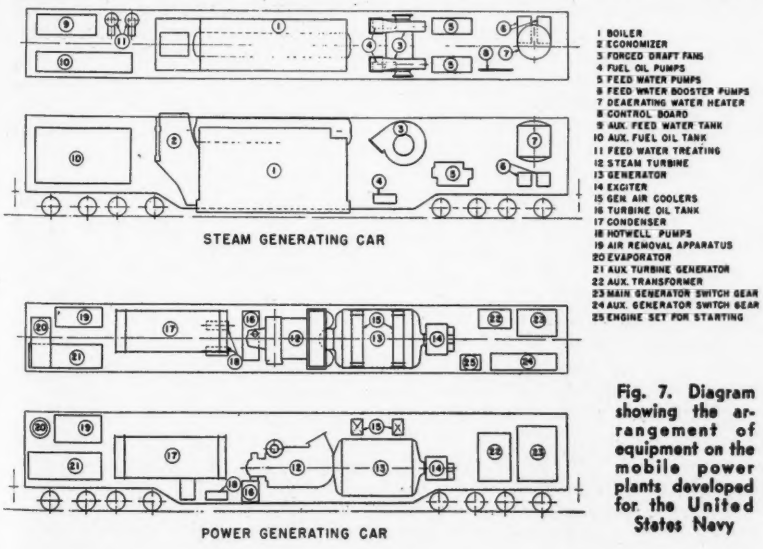


Fig. 7. Diagram showing the arrangement of equipment on the mobile power plants developed for the United States Navy

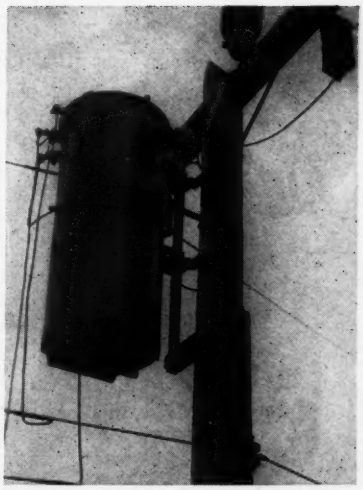


Fig. 8. Distribution transformer sealed airtight like a can. Cover is welded on, the transformer sealed for life (Westinghouse)

The development of a method of flexibly supporting the stator cores of two-pole 60-cycle turbine generators has been completed. This construction isolates the stator core so that mechanical energy of double frequency vibration cannot be transmitted directly to the housing structure through structural members. Ten 3600 r.p.m. units ranging in rating from 31,250 to 81,250 kv-a. are now in operation with flexible core mounting.

Two 5000-hp. Westinghouse motors went to work to produce aluminum sheet required for airplane production in the world's largest aluminum sheet mill—the Alcoa, Tenn., Plant of the Aluminum Company of America. Built especially for this aluminum mill, the motors weigh 240 tons apiece and have the greatest horsepower ever built into machines designed to operate at the slow base speed of 30 r.p.m.

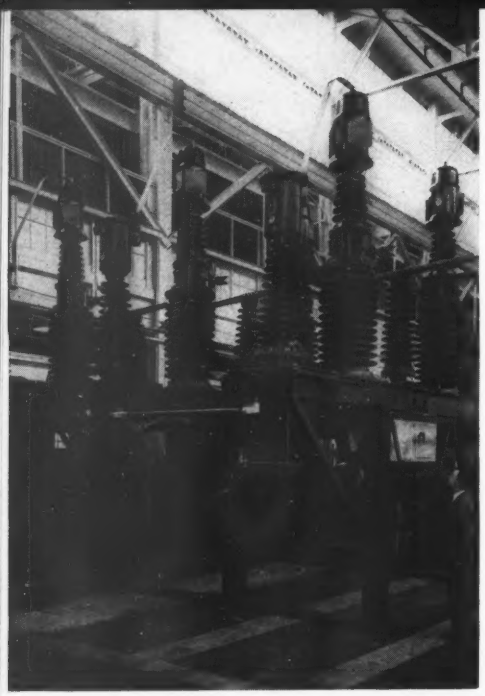


Fig. 9. (Above) G.E. Air-blast breaker, 138,000 v., 600 amp.

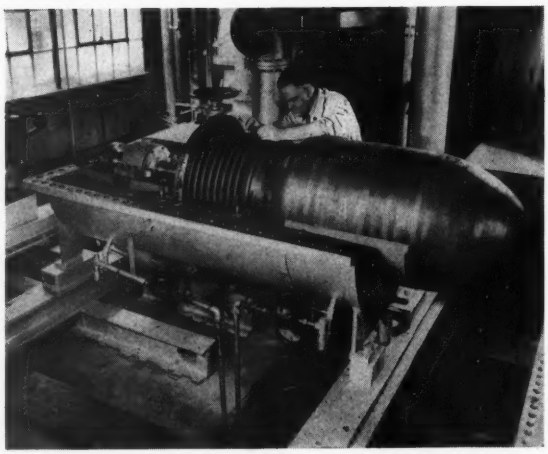


Fig. 10. (Right) Working with a wind tunnel Westinghouse engineers are learning more about the flow of steam in steam turbines

during the year to meet defense requirements. A complete system of 500 lights, including traffic signals, beacons, floodlights and landing lane markers was supplied to the Washington National Airport.

A gigantic ice box where temperatures drop to 20 below zero was added to the test electrical apparatus at the Westinghouse East Pittsburgh Works. It will aid in determining how such devices as compressed air circuit breakers—the safety switches of power lines—operate during cold winters.

A "stop-and-go" power switch was developed to replace fuses on rural lines, insuring continuous power service and reduced maintenance cost. Mounted on poles when a short circuit occurs, this circuit breaker stops the flow of electricity, to direct current were produced during the year.

A motor that produces as much power as 400 automobiles was delivered to the Army's Wright Field in Dayton, Ohio, where it will drive two giant fans in a new wind tunnel to create 400-mile-an-hour gales for the testing of full sized plane propellers and engine enclosures. The motor is rated at 40,000-hp., making it the largest wound-rotor induction motor ever built.

Protected Power for Industry

Westinghouse engineers helped make factory power less vulnerable to sabotage and air raids by applying the secondary network system previously used for city power distribution systems. In addition to protecting factories against great power interruption from sabotage or bombing, the secondary network is more reliable in normal operation.

Westinghouse tripled its production of Ignitrons. Nearly 150 banks of these power regulators which change alternating current

The Westinghouse Lighting Division in Cleveland, Ohio, doubled its output of lighting equipment preventing the trouble from reaching the power house. Five seconds later, the switch restores current to the power system. Because 80 per cent of all power faults are temporary, the brief period between the stop and go provides ample time for most troubles to correct themselves. If the trouble is not temporary, the switch opens the circuit and leaves it open.

A street lamp that can light a longer stretch of roadway resulted from national defense priorities on metals. The great demand for aluminum to build airplanes sent lighting engineers in Cleveland, Ohio, searching for a substitute for the processed aluminum reflectors used on street lights. They developed a method of fitting a silver coated glass reflector inside a spun steel hood, and the result was a fixture as good as the aluminum in all respects—and in some ways it was better. It was possible to design the new reflector to produce a wider angle of light, meaning that a much longer stretch of street can be lighted from a single lamp.

To fill the lighting needs of new industrial plants engaged in national defense work, Westinghouse built a $3,000,000 plant at Fairmont, W. Va., to turn out 50,000 tube-shaped fluorescent lamps a day. In 1941 the demand for fluorescent lamps was more than 20,000,000 units—a 300 per cent increase over 1940. Next year, it is estimated, production will exceed 40,000,000 fluorescent lamps.

SOME DEVELOPMENTS OF THE ALLIS-CHALMERS CO.

Early in 1940, the Allis-Chalmers Electrical Department began to make plans for meeting possible wartime demands for its products. The number of tanks, planes, guns, and other material American industry would have to produce could not be measured alone in the production machinery necessary to turn them out. The need for electric power and electrical equipment to drive those machines was equally important.

A steady flow of vitally needed power plant equipment is leaving the Allis-Chalmers shops every day. In production are many central station turbo-generators and water wheel driven generators and many hundreds of smaller units. Among the larger units that will add urgently needed capacity is a 173,000 kv-a. turbo-generator.

In the marine field production of equipment was increased 1300 per cent! All types of Allis-Chalmers motors, generators, and control equipment are already in operation on cargo vessels, net tenders, submarines, submarine tenders, tugboats, destroyers, and auxiliaries of many kinds.

For the steel-making industry, too, from mine to processed metal, the Allis-Chalmers Co. supplies a wide variety of equipment. Included are motor-generator sets, large motors to drive steel mill rolls, intricate control panels and switchboards that are the nerve centers of steel manufacture, and a new Regulex control that reduces losses due to strip breaking and wrinkling.

To permit fast arc welding of thinner gage metals of many kinds, engineers in the Rectifier division of the Electrical Department have developed the Weld-O-Tron electronic arc welder.

Power Output Soars From War Impetus

Over $600,000,000 poured into the utility industry last year, adds 2,712,000 kw. net to bring the total installed capacity to 44,350,000 kw. Output reaches peak of 168 billion kw-hr. and peak loads increase 10 per cent to cut excess capacity below 10 million kw. E.E.I. survey shows about 9 million kw. scheduled for next 3 yr. but expresses concern over availability of materials and equipment. Utility rates drop but taxes increase to 20.5 ct. per dollar of gross revenue. Including some 12,000,000 kw. in mining and manufacturing industries, the country's generating capacity is now over 56 million kw. and the total annual output from these various sources is well over 200 billion kw-hr.

INCREASES IN DEMANDS for industrial electric power, up 30 per cent due to defense effort, was successfully met in every section of the country during 1941 except for a few weeks in the southeast where extreme drouth made necessary temporary curtailment of non-defense power uses.

Due to shortages of material, to other defense demands on manufacturers of turbines and to labor difficulties, generating capacity actually installed in 1941 fell 600,000-kw. behind installation programs. At the same time peak loads increased 3,250,000-kw. with net additions to generating capacity of but 2,712,000-kw. The difference, 538,000 less than the increase in peak loads, made it necessary to draw to that small extent on reserves.

Installed capacity at the end of the year was 9,600,000-kw. in excess of the sum of individual peak loads, compared with a margin of 10,150,000-kw. last year. This excess capacity will be increased, however, by 3,655,000-kw. of generating capacity scheduled for installation in 1942.

In this connection, however, it is well to remember that the scarcity of basic raw materials and the high state of general employment indicate that further expansion of war production must come primarily by decreasing non-defense business and by longer hours of plant operation. These factors will cause a further growth in energy output (kw-hr.) without much increase in requirements for new generating capacity.

The principal need for additional generating capacity appears to be for increased production of aluminum, magnesium and the products of the electric furnace. According to present defense production programs, it is expected that these items will require in 1942 and 1943 an additional 2,000,-000-kw. capacity. The present construction schedule calling for 6,400,000-kw. of new generating capacity in 1942 and 1943 should cover these requirements.

Generating Capacity 44,350,000-kw.

Of the 2,854,000-kw. of new generating capacity installed in 1941, electric utility companies added 1,986,000, municipal plants added 214,000 and governmental plants added 654,000-kw. The year's installation by electric utility companies represented 88 per cent of their programs announced a year ago.

After deducting equipment retired from service or reduced in capacity rating, the net gain was 2,712,000-kw., with 1,976,000-kw. of steam, 681,000-kw. of hydro electric plants and 56,000-kw. of internal combustion engines. This brings the total central station generating capacity at the end of the year to 44,350,000-kw.

It is important to note that in addition to central station capacity a considerable number of manufacturing plants and mines produce their own electric power. At the end of 1941 the generating capacity of these isolated plants had reached about 12,000,-000-kw., bringing the generating capacity in the United States to a total of 56,000,000-kw. at the end of the year. Manufacturing and mining plants added 1,000,-000-kw. of capacity in 1941 and are expected to add an additional 900,000-kw. in 1942.

New generating capacity to be installed during the next 3 yr. is shown by Table I but priorities may materially influence the scheduled installations.

A re-survey made December 1, 1941, of expected delivery dates of equipment showed that the 1942 schedules have been augmented several hundred thousand kilowatts by installations planned for 1941 but not completed that year, that a large amount of capacity scheduled for 1942 had been deferred to 1943, and considerably more scheduled for 1943 had been deferred to 1944. The table gives the result of this re-survey. Later developments, of course, may cause further deferments in these schedules.

Peak Loads

The sum of the December peak loads on the various systems of the country will show about 10 per cent above the figure for last year, bringing the total to approximately 34.75 million kw. The total installed generating capacity of the country was 9,600,000-kw. more than the sum of the individual peak loads. This margin represents unused capacity which is available to carry additional loads and capacity held in reserve against breakdowns and other emergency conditions, including periods of low water.

In 1941 the electric utility companies of the United States spent in round numbers $600,000,000 on new construction, substantially equal to the construction budget reported at the beginning of the year. The construction expenditures were: 38 per cent for generating capacity; 21 per cent for transmission lines and substations; 37 per cent for distribution lines; and 4 per cent for miscellaneous structures.

Reported 1942 budgets are 10 per cent greater than 1941 budgets but these expenditures will

(Continued on Page 73)

Table I. Thousands of kilowatts scheduled for completion the next 3 yr.

	1942	1943	1944
Private Utilities	2,385	1,960	965
Municipal Plants	123	120	90
Government	1,157	670	345
	3,665	2,750	1,400

Fig. 1. Blasting stumps across the river from Camp Gifford

CLEARING The Grand Coulee Reservoir

THE CLEARING of 54,000 acres of rugged and timbered terrain for Grand Coulee reservoir, one of the largest land clearing operations ever undertaken by the Work Projects Administration, is now virtually complete.

Sponsored by the Bureau of Reclamation of the Interior Department, this project employed approximately 3000 men at its peak and utilized a total of 10,000,000 man hours of labor in a clearing task which, while less spectacular than the construction of the dam proper, was absolutely essential to Grand Coulee's operation. A total of $4,900,000 was expended for wages during the 2½-yr. period of the work.

To assure a reservoir free from floating debris that might injure the dam and its machinery or interfere with navigation and other developments, it was necessary to clear the canyons and valleys of four rivers, the Columbia and its tributaries—the Sanpoil, the Kettle, the Spokane—and rid them of thousands of trees and tons of undergrowth and debris. Thousands of buildings also had to be removed or demolished and more than 3000 people evacuated from the area.

The reservoir will form a lake 151 mi. long, reaching from Grand Coulee Dam in Washington State to the Canadian border, when the waters reach their ultimate height. Gates of the dam were closed last spring, and already the water has backed up 140 mi. and has reached a height sufficient to permit operation of the generators.

Electrical energy from Grand Coulee started flowing into the lines in October. The WPA also has cleared the right-of-way for the erection of lines that will hook in with the Bonneville power circuit. And with Coulee generating at full capacity, one of the largest blocks of firm power in the country will be available for the war effort and development in the Northwest.

Already many metallurgical plants and shipyards working on defense orders are using current from Bonneville, and the addition of Grand Coulee current to the lines will increase the power considerably. It is probable that the current will also be extended to western Idaho, where lie immense phosphate beds, ready to be converted into chemical fertilizer by electrical energy.

The lake will have a surface area of about 82,000 acres. Its 151-mi. length makes it the longest man-made lake in the country. The width will vary from 2000 ft. in the canyons to 4 mi. at the

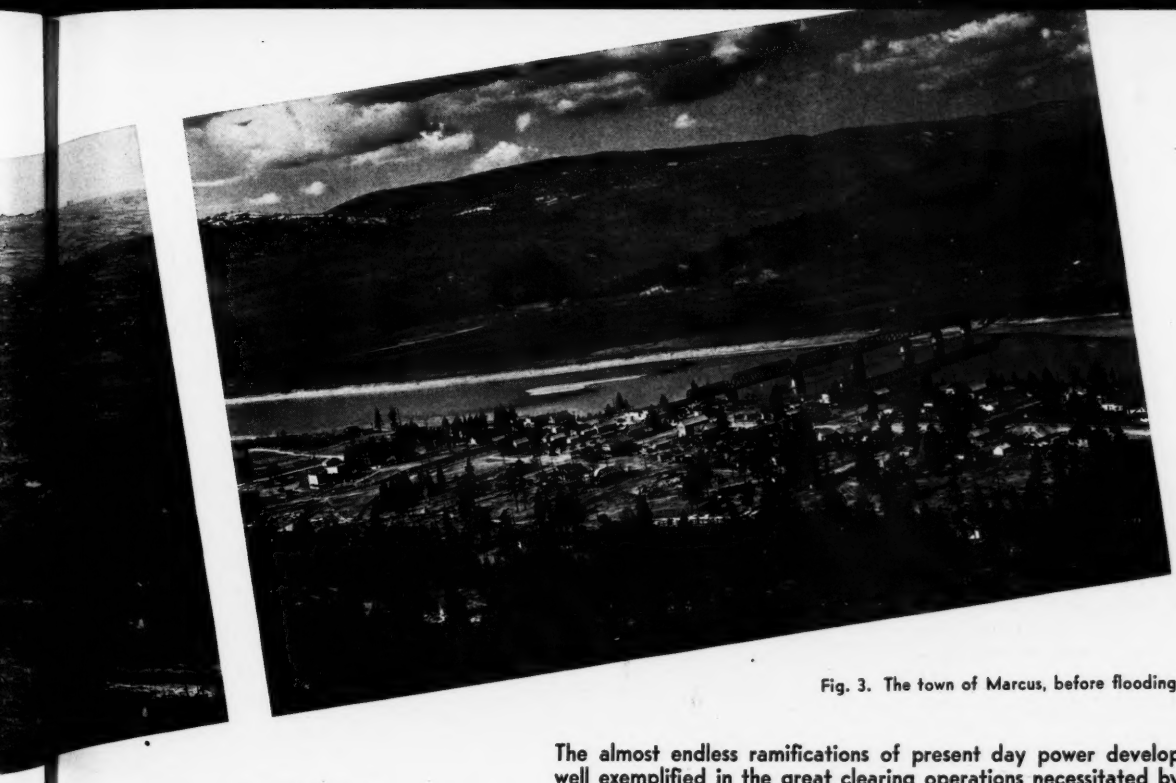


Fig. 3. The town of Marcus, before flooding

Fig. 2. Merchantable timber is hauled to central piles and stacked for transportation to the mills

The almost endless ramifications of present day power development are well exemplified in the great clearing operations necessitated by the construction of Grand Coulee Dam. This article describes briefly the physical aspects of this great undertaking and only hints at some of the social and economic problems involved. This was one of the largest clearing operations ever undertaken by the Work Projects Administration. It involved clearing of 54,000 acres of timbered land

widest point. The maximum depth will be 375 ft. When completely full, the reservoir will hold 10,000,000 acre-feet of water.

A housing and feeding program of considerable proportions was necessary for the army of men engaged in this great clearing operation. Seven camps on ground were erected to house them; and a floating camp, housing 130 men was used to get at places inaccessible from the ground.

Camps Lincoln, Gerome, Clifford, and Keller were semi-permanent wooden barrack camps. Each barrack was 130 by 20 ft., housing 40 men. Camps Spokane, Detillion and Little Falls were tent camps of 200 men each.

Camp Ferry, the floating camp, was built on three barges, each 64 by 24 ft. Double decked superstructures, with sleeping rooms, were erected on two of them, and the third housed the kitchen, mess hall and shower rooms. A smaller barge carried the machine and tool rooms.

Twenty-one boats were used by the clearing crews, all but one of them built on the project. Largest of these was the "Paul Bunyan," 65 ft. long, with a 20-ft. beam and a 4-ft. draft. It was powered by twin Diesel motors of 125-hp.; had a capacity of 100 tons and could carry 300 men. It was used for towing Camp Ferry from place to place and for transporting heavy equipment wherever it is needed.

Prior to clearing operations a large surveying party entered the site of the reservoir to mark the contour lines of the lake. Clearing crews had to follow the lines over all obstacles, removing everything from the bed that would interfere either with navigation or operation of the dam, and everything from above the water line that would fall into the lake and become an obstruction. An extensive survey was made, covering all rivers, creeks and valleys bordering on the upper Columbia; a foray of 30 mi. was made up the Spokane River.

In addition to the Columbia River, Grand Coulee Dam has backed up the Spokane River for 35 mi., and the Sanpoil and the Kettle Rivers for 8 mi.

Fig. 4. All that is left of Marcus now. The Great Northern Bridge is partly under water

About 100,000 acres of land were negotiated for and purchased by the Bureau of Reclamation. Title to all land in the reservoir area, up to 1310 ft. above sea level now rests with the Bureau.

Not only was the land purchased, but possessions of some 3000 persons who lived in the site of the lake were either purchased or moved to higher ground. Whole villages were moved and the ground leveled. Railroad tracks and highways were relocated, bridges torn down and replaced with others out of reach of the water. Churches, schools, fences, utilities and barns were moved, if possible. If not, they were turned over to the WPA for demolition, and with trees, roots and underbrush, were burned. Five hundred farm homes were abandoned; numerous orchards were cut down and grubbed out, including one peach orchard of 12,000 acres at Kettle Falls.

Several villages were uprooted from their sites along the four rivers, the movable possessions moved elsewhere, and the sites leveled. Boyds, a village 117 mi. above the dam, has been moved to nearby benchland, the former site now being under 30 ft. of water. Marcus, largest of the villages affected, with a population of 600, is now on a high flat. Kettle Falls was moved to higher ground at Meyer Falls, 4½ mi. away. Buildings at Daisy and Clifford were razed and the town moved to a hill. Seventy-five feet of water cover their former site. Inchelium has been moved 2 mi. away, as has been Gerome. Their sites are now under 100 ft. of water.

Considerable heavy land clearing equipment was utilized on this project. Equipment was supplied by the Bureau of Reclamation, sponsor of WPA operations. Included were large 70 and 90-hp. tractors equipped with bulldozer blades, logging equipment and double drum hoists. Heavy equipment was essential not only for clearing operations, but also for the construction of access roads to clearing areas, so that fleets of trucks could transport men, equipment and salvageable materials. The construction of these roads through this rugged terrain was by itself an engineering task of huge proportions.

More than 32 million board feet of salable timber has been cut out of the basin, trimmed, and skidded to the river, where it was floated to the dam, and auctioned off to the highest bidder.

Since the gates were closed the water in the reservoir has been rising steadily. By the middle of August the lake had reached out 133 mi., with a stage of 1255 ft. above sea level. Two-thirds of the potential capacity of the reservoir, about 7,000,000 acre-feet is now behind Coulee Dam.

With full operation, Coulee Dam will provide a source of 984,000-kw. of prime power available 95 per cent of the time, and 1,700,000-kw. available 50 per cent of the time. The reservoir, in addition to providing a power source of approximately 1,000,000-kw. in excess of that required for the pumping associated with the Columbia Basin development, will also regulate the flow of the Columbia River and provide a more effective utilization of the water resources of this mighty river.

Only two of the camps, and about 500 men remain to clean up the work. They are engaged in bringing out the last of the salable timber in the higher areas, and in grubbing out the last of the thousands of roots and stumps. Camp Ferry is moving up and down the lake, watching for slides and keeping the booms free of debris.

Other aspects of the creation of the lake, in addition to power and irrigation, are those of transportation and recreation. Ore, ranch products, and timber may eventually be transported not only from the reaches of the lake itself, but from the Arrow Lakes district in British Columbia, with which it will connect at some later date. Recreational facilities have already sprung up, and the lake should soon be one of the outstanding scenic spots of the entire area of the Northwest.

In addition, the combination of transportation and abundant power should give rise to new industries in the territory, and the introduction of water to the fertile but arid land should make it notable in agriculture's history.

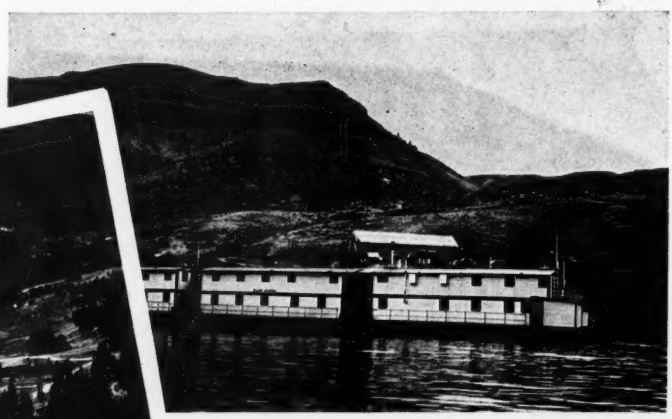


Fig. 5. Above. Camp Ferry, mobile unit used in clearing remote and inaccessible places along the Columbia. Two of the barges are used for sleeping quarters while the third houses dining room, kitchen, office, wash rooms, etc.

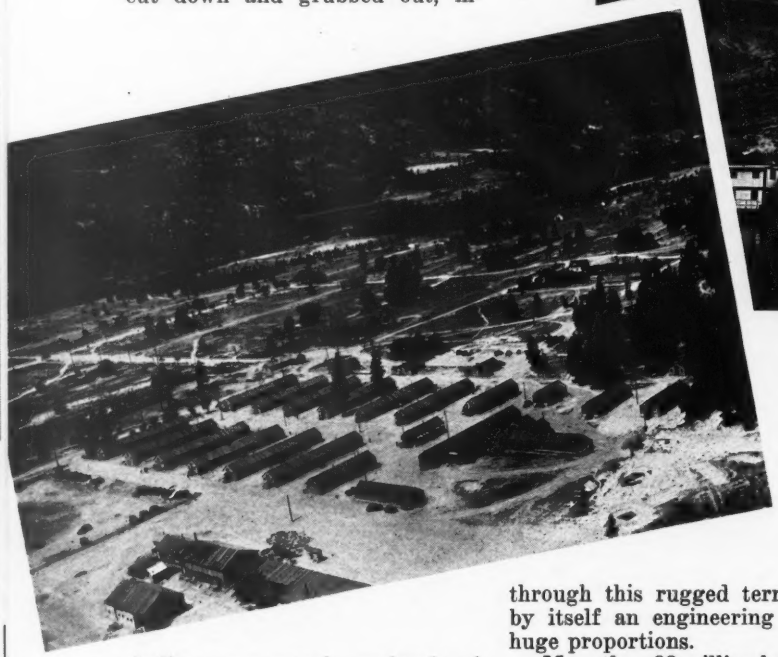


Fig. 6. Left. Camp Kettle close-up looking northwest. Taken at about 300 ft.

War and Drought Force Swiss Hydro Expansion

DUE TO a prolonged period of good weather during the summer and autumn of 1941 Swiss reservoir lakes reached an unprecedented low level. The month of September, 1941, was the driest since 1898 and even October rainfall was abnormally low.

As a result the Swiss Federal Railroads drew on the reservoir supplies much earlier than usual and even further restricted schedules which for other reasons already had been curtailed. Heating of passenger coaches during the winter of 1941-1942 has also been strictly regulated.

By producing yearly 8 billion kw-hr. of electrical energy, Switzerland, a neutral but completely landlocked little country, occupies first rank in Europe in the use of national water power resources. However, following a ruling of the Federal Department of Economics, a 15 per cent reduction in public consumption of electricity went into effect on November 15, 1941. Street lighting throughout the country has been reduced by 30 per cent, and lights in shop windows have to be turned off nightly at 8:30 p.m. Use of electric heaters in homes, except in cases of illness, is prohibited.

Some 77 per cent of Switzerland's electric power is produced in winter from direct water supplies and only 23 per cent is furnished by reservoirs filled during the summer season. Since the first World War power stations in Switzerland have quadrupled their capacity and at a first glance power shortage seems paradoxical. It must be remembered, however, that since 1914-1918 artificial illumination has been changed entirely to electricity, as has the motive power in factories. Moreover, 90 per cent of the traffic of the Swiss Federal Railroads is electric powered.

Construction costs of power stations had reached 700 million Swiss Francs by the outbreak of the first World War. Since then a further 2 billion Swiss Francs have been invested in this field. The value of the electric energy which Switzerland uses yearly amounts to 280-300 million Swiss Francs. In spite of these tremendous investments, however, the production of electric power has not been able to keep pace with the ever increasing demands. For this reason a new expansion program approximating the one carried out during the last 20 yr. is now being considered.

Switzerland has always been an exporter of electric power. This export today is involved with the importation of coal, although restrictions corresponding with those prevailing for home consumption are foreseen in cases where there are no specific obligations. It is felt that Switzerland has to continue exports of electric current in order to safeguard her markets for electric energy after the war.

ROMANCE IN ARMAMENT WORK

MAKING PLANES, guns and tanks seems a prosaic machine job, but the search for men and equipment to aid in production has developed many mild thrills and adventures. Instances of men brought back from retirement to industrial activity are numerous, one notable case being a bee-keeper who turned out to be a skillful die maker.

General Electric was one of the large firms called on, and early drew into its subcontracting, known plants which had been working on special equipment. Some 150 concerns scattered over hundreds of miles are providing a steady flow of needed parts. This was notable but routine in that it was simply a matter of organizing known sources. When it came to finding smaller organizations, the search took on the nature of a treasure hunt. Where are they? What can they do? How much can they do?

In an extensive campaign by letters, advertising and personal search, some 1500 firms were unearthed. Many were not able to undertake work then available, but some 400 subcontractors were found who are doing work ranging from delicate machinery to 40-t. castings. Some were supplied with tools, dies, supervisors and inspectors to assist; also help was given in getting materials needed.

After weeks of search for somebody to produce a small machine part, a fishing tackle manufacturer took on the job and made good. For small taper pins, after trying several shops, a watch-making concern proved to be the answer. Steel radio cabinets were a problem until a burial casket company adapted its plant to forming steel panels. A maker of miniature gasoline engines for toy airplanes, small and weighing 12 oz., offered to help, and is now doing precision work on which some large machine shops had not qualified. Electroplating of searchlight reflectors, after repeated trials by several firms, was finally placed with a small firm in a basement workshop.

UNGROUNDED GROUND WIRE SUPPLIES BEACON

WHERE a high-voltage power line ran close to a large municipal airport, it was necessary to mount a warning beacon on top of each tower. To do this an ingenious scheme of supplying power to the lights has been devised by Westinghouse engineers using a completely self-protected distribution transformer at each pole top, one for each beacon, each transformer supplied with power through an "ungrounded ground wire".

For 7½ mi. of the 220 kv. line one of the two ground wires has been insulated from ground, and made to carry the hot side of a 2400 v., single-phase supply. The remaining ground wire acts as the return. At each pole the distribution transformer steps the voltage down to that required for the beacon. To prevent flashover and outage of the 2400-v. circuit, a De-ion protector tube is mounted on each insulator. Transformers 130 ft. in the air on steel towers make a perfect target for a lightning stroke, so they are of the completely self-protecting type, with built-in De-ion tubes that bypass lightning.

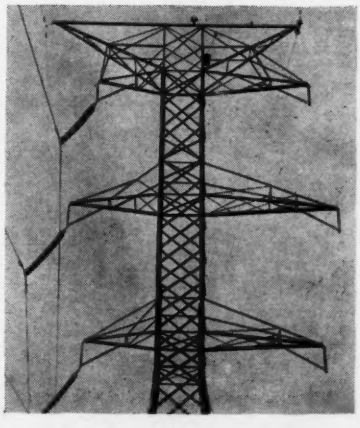


Fig. 1. The small black dot at the tower top is a distribution transformer which supplies power to an airplane-warning light above it by a novel scheme in which one ground wire is ungrounded

A Rapid Method For Coal Analysis

By R. BELCHER and C. E. SPOONER
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CARBON and hydrogen are the most important elements in coal and their accurate determination has remained the most difficult of the analytical methods. The conventional Liebig method requires the combustion in oxygen of 0.2 gm. of coal in a glass tube 1 meter in length packed with 35 cm. of copper oxide and 8 cm. of lead chromate, the copper oxide being heated to 800 deg. C. and the lead chromate (to remove sulphur dioxide) to 600 deg. C.

The liberation of large quantities of hydrocarbons from coal required slow combustion to ensure complete oxidation in contact with copper oxide, and the temperature of 800 deg. C. was so near the fusion temperature of the combustion tube that frequent failures and the need for repacking occurred. The complex packing made the drying of the tube a very slow operation and frequent blanks were necessary to ensure dryness.

In 1920 Vita[1] developed a new method for the determination of sulphur in coal using a high temperature with excess oxygen to carry out the combustion. This was later confirmed by Seuthe[2], but A. E. Beet and R. Belcher[3] showed that chlorine interfered with the determination of sulphur and modified the procedure to determine sulphur and chlorine simultaneously.

Several months ago R. Belcher[4] showed that the high temperature technique could be applied to the determination of carbon in coal, and the work which is now described is a further development which enables the carbon, hydrogen, sulphur and chlorine to be determined simultaneously in 60 min. using simple robust apparatus and a tube which requires no packing.

The method, in essence, consists in burning 0.5 gm. of coal in a rapid stream of oxygen at a temperature of 1350 deg. C. and absorbing the sulphur oxides and chlorine in a spiral of silver gauze, the water in anhydrone and the carbon dioxide in soda asbestos. The silver sulphate is removed by solution in hot water, and the silver chloride by solution in ammonia. Loss in weight of the silver after each treatment gives the amounts of sulphate and chloride, and increase in weight of the anhydrone and soda asbestos gives the weights of water and carbon dioxide.

The temperature of the silver spiral is important, and under these conditions a temperature of 800 deg. C. approximately is necessary to retain the sulphur. Since the length of the spiral is only 2 in., it is possible to find a position near the outlet of the furnace where the required temperature occurs, and to confirm the completeness of absorption of the sulphur oxides and chlorine by a series of trials. The spiral is pushed about 3 in. from the outlet end of the tube and a bubbler containing 1 per cent solution of hydrogen peroxide is connected.

A boat contains 0.5 gm. of coal which is burnt in oxygen as in this standard test to be described later, and the amounts of sulphur oxides passing the spiral is determined by titration with $\frac{N}{20}$ NaOH. The spiral is moved a further quarter of an inch from the outlet of the tube and a further determination is made. This is repeated until a position is found giving a titer[5] of not more than 0.2 ml. of $\frac{N}{20}$ NaOH. It is advantageous to use a notched metal rod to push the spiral in to the optimum position for each determination. It has been found to be convenient to reduce the rate at which the temperature drops at the outlet end of the furnace by placing a block of insulating firebrick over the end connections of the Silit rods at this end of the furnace, the brick being hollowed out to take these projecting ends.

The method can be used either for the determination of carbon and hydrogen only, in which case the spiral of silver is not removed from the furnace between each determination or it can be used to determine all four elements simultaneously.

Sulphur Determination

When used for the determination of sulphur, a factor of 0.1065 instead of 0.1025 is used to convert silver sulphate to sulphur. The reason for this has not been ascertained. It is not due to impurity in the silver, which is 99.9

[1] A. Vita; Stahl und Eisen; 1920, 40, 933.
[2] A. Seuthe; Gluckauf; 1939, 19, 409.
[3] R. Belcher and A. E. Beet; "Fuel in Science & Practice" 1940, xix, 42.
[4] R. Belcher: "Fuel in Science & Practice" 1940, xix, 172.

[5] This term is used to designate the amount which a normal solution differs from a true standard.

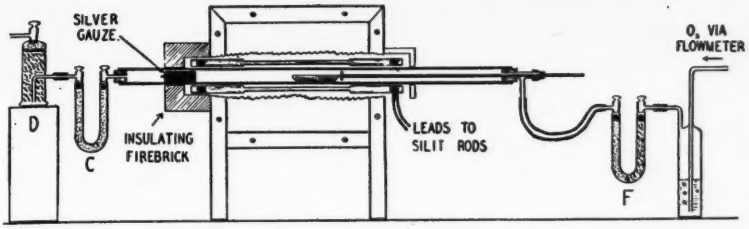
Power plant engineers in the United States have not used the ultimate analysis of coal to the extent that it probably deserves, particularly with coals containing high percentages of sulphur. One of the reasons for this is the difficulty in making the analysis. With the aid of the new method described in this article, power house chemists may find a satisfactory short cut.

Robert Williamson of the Industrial Publicity Unit, London, England, in transmitting the article to the Editor of Power Plant Engineering writes as follows:

"Two members of the Department of Fuel Technology in the University of Sheffield have been good enough to let me have a rather technical article on a rapid method for the ultimate analysis of coal.

"It occurs to me that the conclusions arrived at by these two authorities would be of definite interest to the readers of Power Plant Engineering and I am, therefore, venturing to send you the article for exclusive publication in U.S.A.

"It is one of the issues of the Industrial Publicity Unit set up by the Department of Overseas Trade 6 mo. before the war, to make known overseas the achievements of all parts of British industry."



General arrangement of apparatus used in the ultimate analysis of coal. Illustration from "Fuels in Science and Practice"

per cent pure, and not due to loss of sulphur oxides, the recovery being not less than 99 per cent. It may be due to the fact that the sulphur is not all converted to sulphate. The small amount of chlorine makes its exact determination by gravimetric methods more difficult and therefore only quasi-quantitative accuracy is claimed if the chlorine is less than 0.05 per cent, but with higher amounts greater accuracy is obtained. Since, however, such small amounts are relatively unimportant, this offers no drawback to the method, since it will indicate whether or not the chlorine approaches objectionable amounts.

A number of coals have been analyzed by this method and good agreement has been obtained with results obtained by the conventional methods for coals ranging from anthracites to high volatile steam coals including cannels. The method can, therefore, be used with complete confidence for the whole range of coals.

Apparatus

(1) High-temperature furnace heated by Silit rods or Globars to enable a temperature of 1350 deg. C. to be attained. For this temperature a casing of 11¼ in. by 9¼ in. by 9¼ in. suffices, mounted on four legs. The usual Sindanyo[6] cover at one end is replaced by a block of insulating firebrick 3 in. by 6 in. by 4½ in. in which a hollow 1¾ in. by 3½ in. by 2½ in. is made to take the Silit rod connection.

(2) A refractory tube 26 in. long ⅞ in. bore of Pythagoras[6] or Triangle H ware. The exit end should protrude 3 in. beyond the end of the insulating brick.

(3) Unglazed porcelain boats 3 in. by ½ in.

(4) A silica pusher with a disk end to move the boat into the hot zone. This passes loosely through a T-piece which is inserted through a rubber ring in the inlet end of the refractory tube, and the other end of the T-piece having a short piece of rubber tubing through which the pusher can move.

(5) An inclined-gage flow meter for measuring a flow of 300 ml./min.

(6) U-tube charged with anhydrone.

(7) Midvale tube charged with soda asbestos and backed with anhydrone.

(8) Oxygen-purifying train consisting of a sulphuric acid bubbler, and a U-tube packed with soda asbestos and anhydrone.

(9) A silver gauze spiral made from pure silver gauze of approximately 20 mesh, 12 in. by 2½ in. rolled to fit snugly into the refractory tube. A loop is pulled out at one end as a grip for crucible tongs.

(10) Reagents. Finely divided alumina (this may contain a small amount of moisture liberated above 1000 deg. C. so this should be determined and the blank deducted from the total moisture recovered by the anhydrone.) Anhydrone (magnesium perchlorate). Soda asbestos,[6] ammonium hydroxide 0.880 S.G. Industrial alcohol. Ether.

Insert the silver gauze spiral into the position which has been previously determined, using the notched bar, and leave for 10 min. to attain the correct temperature. Meanwhile, weigh the absorption tubes and connect to the exit end of the refractory tube, and the purifying train to the cylinder of oxygen, and adjust the flow to 300 ml. per min. by means of the flow meter. Insert the boat (which has previously been dried at 105 deg. C.) containing 0.5 gm. of air-dried coal covered with 0.5 gm. of alumina. Push the boat slowly into the hot zone during 6 min. and allow the boat to remain in the hot zone for a further 4 min.

Detach the absorption tubes and connect in series in a scavenging train consisting of U-tubes containing soda asbestos, anhydrone, the absorption tubes from the combustion test and a sulphuric acid bubbler. Draw air through rapidly for about 5 min. and place the absorption tubes to cool and then weigh.

Withdraw the silver spiral, cool on a clean metal block and weigh. Remove the silver sulphate by immersion in a beaker containing 200 ml. of boiling distilled water for 2 min. Wash and repeat using fresh water. Wash and dry by immersing in industrial alcohol and ether successively, shaking between each operation, and burn off the residual ether in a bunsen flame until the spiral just begins to glow dull red. Cool on the metal block and weigh.

Remove the silver chloride by gentle agitation for 2 min. in a wide-necked bottle containing ammonium hydroxide. Repeat using a second bottle, wash, dry as in the previous operation and weigh.

Using 0.5 gm. of coal the factors are:

$$\text{Carbon} = CO_2 \times 3/11 \times \frac{100\%}{0.5}$$

$$\text{Hydrogen} = H_2O \times 1/9 \times \frac{100\%}{0.5}$$

$$\text{Sulphur} = Ag_2SO_4 \times 0.1065 \times \frac{100\%}{0.5}$$

$$\text{Chlorine} = AgCl \times \frac{35.5}{143.5} \times \frac{100\%}{0.5}$$

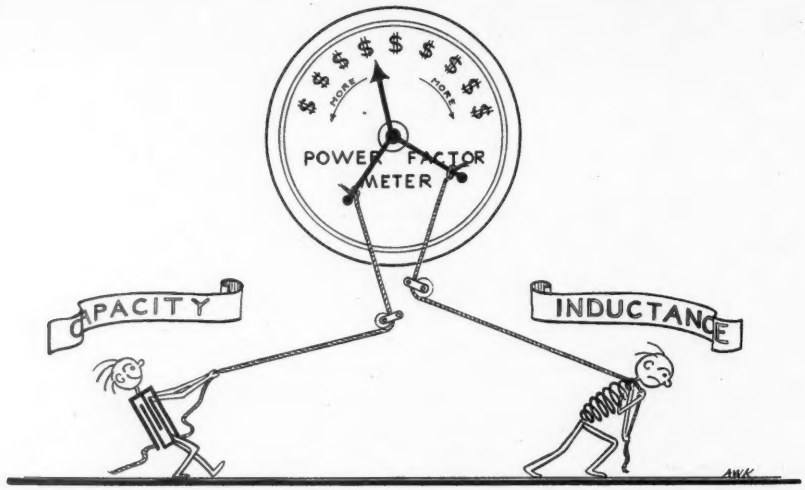
[6]The American equivalent of Sindanyo is transite. Pythagoras is Sillimanite or mullite porcelain and soda asbestos is equivalent to Ascarite.

WAGES BREAK RECORD

AVERAGE weekly compensation of wage earners in 25 manufacturing industries amounted to $35.63 in October, as compared with $35.10 in September, according to the Division of Industrial Economics of The Conference Board.

From January, 1938, when average weekly wages in these industries amounted to $22.85, to November, 1940, when they were $29.73, the rise was caused primarily by increased working time, which expanded from 32.2 to 39.6 hr. per wk. Since November, 1940, the rise has been caused primarily by increases in average hourly earnings, which began rising rapidly in December, 1940, so that in October, 1941, they amounted to 85.3 ct. as compared with 74.7 ct. in November, 1940.

Increases in average hourly earnings since November, 1940, has been caused primarily by wage rate increases. Increased overtime payments have also been a factor, because hours of work expanded further to 41.7 per week in October, 1941.



POWER FACTOR AND POWER FACTOR ECONOMY

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THE TERM POWER FACTOR comes up often in connection with industrial plant operations because every plant superintendent is concerned with problems associated with power factor. Some of the more important of these problems concern the cost of electrical energy to the plant, the losses in the plant circuits, and the performance of electrical equipment in the plant.

The use of capacitors to improve power factor is quite general. The principles involved in their application are not generally understood, however, and the subject becomes rather complicated when attempting to decide how many capacitors to use, what kind, where they should be located, and how they should be operated to get the best overall results.

Power factor simply is a means of expressing the ratio of useful current to wattless current. It may, however, be used in many different ways to express a set of conditions. When concerned with the conditions prevailing during peak load periods, viewing the entire plant as one load, we speak of the peak-load power factor or the demand kv-a. and demand kw. Sometimes we are concerned with sustained peak loads as indicated on a 15-min. demand meter; sometimes we are interested in instantaneous peaks of very short duration as set up by resistance welder loads that are too short to show up on 15-min. demand meters. The short time peaks, nevertheless, cause severe voltage dips, lamp flicker, and general disturbance on the power circuits. Instantaneous peak power factor problems involve the use of series capacitors and require special study of specific applications. Since this article is confined to shunt capacitors, this type of application will not be included in the discussion.

Method of Billing A.C. Power

Obviously, it is quite important to analyze plant conditions, power factor, and reasons for correcting power factor before a selection of capacitors is attempted. Power factor in itself is not so important as the power factor under the predominating load conditions. Of importance, also, are the method and time of power factor determinations.

It is common practice today for utilities to base the billing for electric service not only on the actual kilowatt hours consumed but also on the other factors associated with delivery of this consumed power. One very important factor is the magnetizing current. Practically all industrial plant electrical loads can be considered as being made up of two components, the work producing current, and the "magnetizing" current. While the actual power consumed is determined by the power current only, the total current required determines the size of the generators, lines, transformers, regulators and other equipment used to supply the service. The amount of real power that can be supplied over a given system is limited by the value of the magnetizing current flowing in that portion of the system.

All inductive apparatus such as induction motors, welders, and transformers draw both power

current and magnetizing current. The latter, often referred to as reactive current, is the lagging current caused by the magnetic fields associated with such devices.

The term power factor is simply a method of expressing the proportion of power current to a given total current under consideration. The term power factor may be used to express this relation on a momentary basis, or it may be used to express the prevailing proportion over a long period, such as a month. In determining the investment in equipment necessary to serve a given peak load, the utilities are concerned with the power factor at peak load. In determining the cost of supplying service over a long period, the average power factor is important because of the heating limitations of the lines, transformers, generators and other equipment comprising the system.

Electric Power Rates and Rate Structure Details

Most electric power schedules are designed to vary the billing revenue received, in accordance with variations in the power factor. Some schedules have an additional charge when the power factor of the load falls down below a certain value; in others the charge is reduced when the power factor is above a certain value. Many schedules contain provisions for raising or lowering the charge over a wide range of power factor values above and below a certain power factor. This is done with respect to peak by the kv-a. demand charge. The kv-a. demand charge includes both magnetizing and power current. In the case of the monthly charge, the ratio of kw-hr. to reactive kv-a.-hr. are used. The kw-hr. are, of course, the product of the power current times the voltage times the hours. The reactive kv-a.-hr. are the product of the magnetizing current times the voltage times the hours.

Some schedules use a calculated kv-a. demand charge obtained by multiplying the kw. demand by a factor which takes into account the ratio of integrated reactive kv-a.-hr. and kw-hr. over the month. Quite often this calculated kv-a. demand charge enters into the calculation of the energy charge. Thus when the ratio of reactive kv-a.hr. to kw-hr. is improved both the demand charge and the energy charge are reduced.

As pointed out above, charge for electric service usually depends upon the amount of magnetizing current taken from the line along with the power current. If the load power factor is 70.7 per cent, the magnetizing or so-called wattless current is equal to the power current.

Types of Rates Determine the Capacitor Application

For the purpose of analyzing the different types of rates a typical application may be considered. Let us consider an industrial plant with a day load averaging 960-kw. and 67 per cent power factor, with peak loads running up to 1200-kw. and 75 per cent power factor. It is obvious that a large magnetizing current will be drawn from the line, and considerable savings may be made by supplying this magnetizing current from a capacitor. The size of the capacitor and the merits of its use can be determined only by systematic analysis.

It may be found that one of the following conditions exist.

(a) Power factor is not considered in the rates.

(b) Power factor is taken into account in demand charge.

(c) Power factor is checked by test and used to determine energy charge thereafter.

(d) Power factor is determined by kw-hr. and reactive kv-a.-hr. and used to modify the demand charge or energy charge or both.

(a) If the power factor is not included in the rates, the capacitor can be used only to secure savings in the plant. Such savings are inherent in a reduction of current in circuits, a load reduction on transformers, and, of course, reduced loads on customer-operated generators. The location of the capacitor should be near the low power factor loads and on the circuits to be relieved. The size can be determined easily by simply calculating the reactive kv-a. and using a capacitor large enough to supply all or part of this reactive kv-a., thus, reducing the current in the circuit to the desired

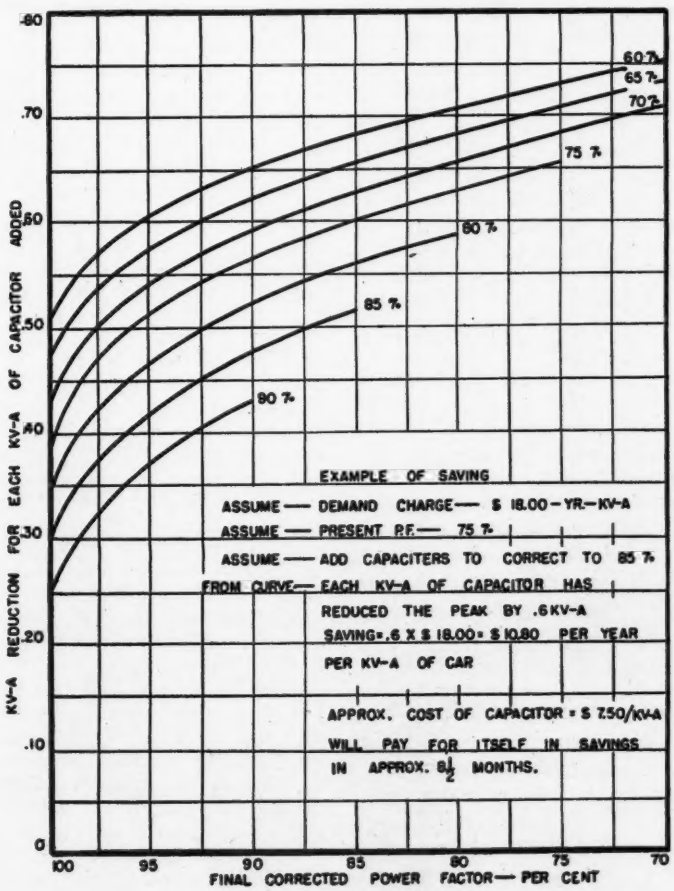

Fig. 1. Reduction of peak kv-a. loads and savings in demand charges by the use of capacitors

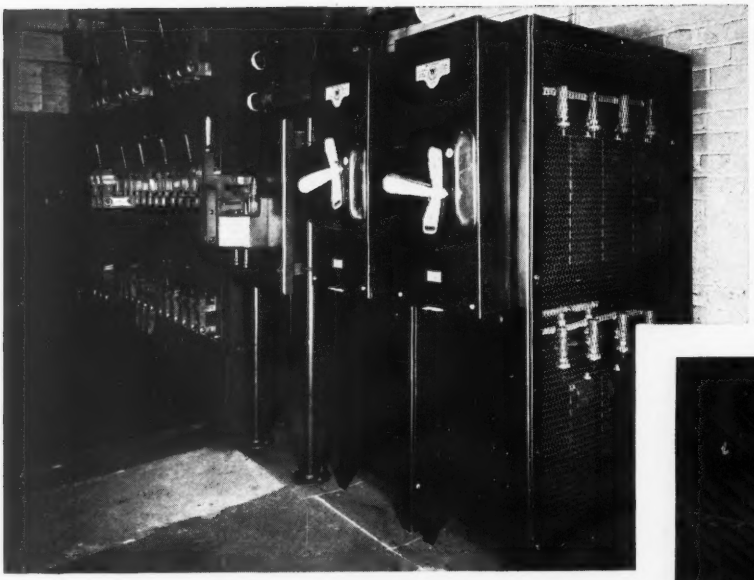

Fig. 2. (Above) A bank of two 120 kv-a., 460 v. small rack capacitors installed in an industrial plant

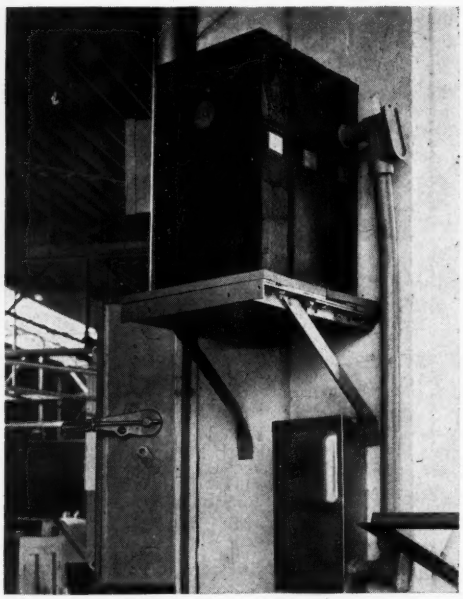

Fig. 3. (Right) This 20 kv-a., 220 v., 3-phase unit, consisting of three individual dust tight capacitors, cost $368 and saves about $145 per year

figure or the power current value.

(b) If the power factor is low, the demand kv-a. will be high. If the rates include a kv-a. demand charge, this may be reduced by raising the power factor during the demand peak. With a demand 1200-kw. 75 per cent power factor the kv-a. demand is

$$1200 \div 0.75 = 1600 \text{ kv-a.}$$

If the power factor is raised to 95 per cent the demand kv-a. is

$$1200 \div 0.95 = 1260 \text{ kv-a.}$$

The size of the capacitor required to accomplish this is determined from the reactive kv-a. at the two power factor values as follows:

Reactive kv-a. at 75 per cent power factor

$$= \sqrt{1600^2 - 1200^2} = 1060 \text{ kv-a.}$$

Reactive kv-a. at 95 per cent power factor

$$= \sqrt{1260^2 - 1200^2} = 387 \text{ kv-a.}$$

The kv-a. rating of the capacitor required is 1060 — 387 or 673 kv-a. The reduction in the kv-a. demand from 1600 to 1260 may result either in a reduced kv-a. demand charge or it may actually reduce the energy charge depending on the rates structure. Some rates involve several energy charges for successive blocks of power, the size of the blocks depending on the kv-a. demand. For example:

Size of block = 70 × kv-a. demand.
1st block, 5c per kw-hr.
2nd block, 1¼c per hr.
3rd block, 1c per kw-hr.
Additional, ¾c per kw-hr.

It is plain to see that in this case the energy charge will be reduced by reduction in kv-a. demand because if the blocks are smaller the customer will reach the low rate on a larger proportion of the energy consumed.

Some rates provide a charge per kv-a. demand. Figure 1 shows the savings which can be made on this basis for a typical demand charge.

(c) Sometimes a check is made on the average power factor under day-load conditions, and the billing, thereafter, is based on this value until some future check is made. The energy charge of the net billing is adjusted up or down according to this average power factor. In such cases it is necessary to determine how this check is to be made and under what conditions. Then capacitors can be installed to raise the power factor as high as warranted by the expected savings. After the capacitor is installed the utility will be asked to again check the power factor and set up new rates accordingly. Such a capacitor is usually made proportional to day-load requirements. In the case above, the day load averaged 960-kw. at 67 per cent power factor. Assuming this is to be brought up to 95 per cent power factor, a 745 kv-a. capacitor is required as follows:

$$960 \div 0.67 = 1430 \text{ kv-a.}$$

Reactive kv-a. at 67 per cent power factor $= \sqrt{1430^2 - 960^2} =$ 1060 kv-a.

Reactive kv-a. at 95 per cent power factor $960 \div 0.95 = 1010$ kv-a. Reactive kv-a. at 95 per cent power factor $= \sqrt{1010^2 - 960^2} = 315$ kv-a. Capacitor kv-a. required $=$ $1060 - 315 = 745$ kv-a.

(d) The method most commonly encountered in industrial plants today is the one which takes into account monthly power factor obtained by integrating kw-hr. and kv-a.-hr. Assuming the plant mentioned above is billed for 322,250 kw-hr., and that the reactive kv-a.-hr. equal 346,000. This ratio amounts to a power factor of 68 per cent. Assuming that rates indicate that it will be worthwhile to reduce this reactive kv-a.-hr. to a point corresponding to 95 per cent power factor, the total kv-a.-hr. at 95 per cent power factor $=$ $322,250 \div 0.95 = 339,000$.

Reactive kv-a.-hr. at 95 per cent $= \sqrt{339,000^2 - 322,250^2} = 106,000$ reactive kv-a.-hr. Therefore, the reactive kv-a.-hr. must be reduced

from 346,000 to 106,000. This can be accomplished with a capacitor that will supply the difference, or 240,000 r kv-a.-hr.

The capacitor must be of such a size that for a one month period the product of its effective kv-a. times the hours of use will amount to 240,000 r kv-a.-hr. It will always be effective for any period during which it does not correct the load to leading. The determination of this capacitor requires a study of load charts if the smallest possible capacitor is to be determined.

If the meters are not ratcheted, the size of the capacitor may be determined by dividing 240,000 by the number of hours in the month, i.e., 240,000 ÷ 730 = 328 kv-a.

Calculation of Savings

The rates throughout the country vary a great deal as to the method used for taking power factor into account. The following analysis is based on a typical rate. The details are as follows:

1. Scope of schedule — 5 kv-a. to 18,000 kv-a.
2. Demand Charge
   - 1st 2 kv-a. of billing demand. $5.50
   - Next 3 kv-a. of billing demand. 2.10 each
   - Next 25 kv-a. of billing demand 2.00 each
   - Next 70 kv-a. of billing demand. 1.50 each
   - Next 200 kv-a. of billing demand. 1.00 each
   - Next 700 kv-a. of billing demand. .50 each
   - Over 1000 kv-a. of billing demand. .25 each
3. Energy Charge Cents per kw-hr.
   - 1st 1000 kw-hr. 1.7
   - 80 kw-hr. per kv-a. of billing demand 1.5
   - Additional kw-hr. 5
4. Meters Used
   - Kw-hr. meter with 15 min. demand attachment. Reactive kv-a.-hr. meter.
5. Determination of Billing Demand kv-a. Billing kv-a. demand

$$= \text{kw. demand} \times \sqrt{1 + \frac{\text{rkv-a.-hr.}^2}{\text{kw-hr.}}}$$

It will be noted that in the above type of rate the reactive kv-a.-hr. for the month and the kw-hr. for the month are used to determine the calculation of kv-a. demand called the "Billing kv-a. demand."

Taking the typical case above and with the following basis the present billing would be as follows:

Kw-hr. consumed per month = 322,250

Rkv-a.-hr. consumed per month = 346,000

Kw. demand = 1200

Billing kv-a. demand is then

$$= 1200 \times \sqrt{1 + \left(\frac{346{,}000^2}{322{,}250}\right)} = 1755 \text{ kv-a.}$$

Demand Charge		
Kv-a.	*at*	*Equals*
2	$5.50	$ 5.50
3	2.10	6.30
25	2.00	50.00
70	1.50	105.00
200	1.00	200.00
700	.50	350.00
755	.25	188.75
1755 Total Demand Charge		$905.55

Energy Demand	
1st block 1000-kw-hr. at 1.7c =	$ 17.00
80 × 1755 = 140,400 at 1½c =	2106.00
Remainder = 180,850 at ½c =	904.25
Total Energy Charge	$3027.25
Total Demand and Energy	$3932.80

If the monthly power factor is to be raised to 95 per cent, the reactive hours must be reduced from 346,000 to 106,000.

After examining the load and the periods during which the loads are sustained throughout the month let us assume that a 550 kv-a. capacitor will be sufficiently effective to reduce the rkv-a.-hr. to 106,000. A 550 kv-a. capacitor operating continuously throughout the month or 730 hr. will result in 401,500 reactive kv-a.-hr. This is not 100 per cent effective as pointed out before, only the reactive kv-a.-hr. sustained while the power factor is unity or lagging will record on the usual metering equipment. We need 240,000 reactive kv-a.-hr. effective. We will assume that analysis has shown that this will be accomplished with a 550 kv-a. capacitor.

The bill would therefore be as follows after the capacitor is installed:

Kw-hr. consumed per month = 322,250

Rkv-a.-hr. per month = 106,000

Kw. demand = 1200

Billing kv-a. demand

$$= 1200 \times \sqrt{1 + \left(\frac{106000^2}{322250}\right)} = 1260 \text{ kv-a.}$$

Demand Charge		
Kv-a.	*at*	*Equals*
2	$5.50	$ 5.50
3	2.10	6.30
25	2.00	50.00
70	1.50	105.00
200	1.00	200.00
700	.50	350.00
260	.25	65.00
Total 1260		$781.80

Energy Charge	
1st block 1000 kw-hr. at 1.7c =	$ 17.00
80 × 1260 = 100,800 at 1.5c =	1512.00
Remainder = 220,450 at ½c =	1102.00
Total Energy Charge	$2631.00

Total Demand and Energy Chg.	$3412.80
Yearly savings on Demand Chg.	$1485.00
Yearly savings on Energy	$4755.00
Total yearly savings	$6240.00
Cost of 550 kv-a. capacitor	$4200.00

Cost of capacitor is recovered in less than 9 mo.

As shown above, the same plant might require a 673 kv-a. capacitor if the problem is simply to correct the kv-a. demand power factor, a 745 kv-a. capacitor if the peak load is to be corrected, and if one is primarily concerned with correcting the monthly power factor either a 328 kv-a. capacitor or a 550 kv-a. capacitor or some other value above 328 is needed depending on the load conditions prevailing during the month.

It is therefore necessary to determine the reasons for correcting the power factor before the correct size capacitor can be arrived at. This means a close study of the plant load conditions and the prevailing rate schedule and the way power factor enters into the rates. It is well to consider other alternate power rates that would be available and desirable when power factor correction is to be adopted. Sometimes a rate which is unattractive without correction would be the best rate for the user after correction is applied; and not only installation of capacitors is to be considered but also a change to an alternate rate schedule.

POWER INTERCHANGE TRANSFORMER

Merits of applying transformer capacity on the basis of maximum allowable copper temperature is demonstrated by a Westinghouse 12,000 kv-a. transformer used on the interconnection between the 66-kv. system of the Wisconsin Power & Light Co., and the 13.2-kv. system of the Madison Gas & Elec. Co. The transformer provides an interconnection capacity of 200 per cent of rating when required under emergency conditions for periods up to two hours. In applying the scheme of operation by copper temperature, the rating of this transformer was reduced to half its short time carrying capacity thereby materially reducing the necessary investment.

Operation by copper temperature was further improved by an all-electric relay suitable for remote control. It has no mechanical coupling and no handwheels to operate.

Exhaust Gas, Dew Points And Engine Lubrication

Calculation of air requirements and products of combustion for all common fuels burned in boilers or internal combustion engines reduced to a matter of simple arithmetic by a new and complete data table. Determination of the dewpoint of exhaust gases for boilers or engines simplified by means of a new chart. Effect of condensation from exhaust gases on lubrication, cylinder wear and corrosion of internal combustion engines investigated and higher jacket water temperatures operating recommended

By Bill Maddock

SINCE a determination of the dew point of exhaust gases requires a detailed knowledge of products of combustion, the first part of this article deals with specific phases of the combustion process. Articles[1] on combustion calculations generally presuppose a definite working knowledge of chemistry, which the average reader may not have.

Engineers, however, are of necessity more or less familiar with tables and charts so that an approach from this angle is more likely to be understood. In this connection Table I gives all the common fuels, the products of, and air requirements for, perfect combustion. Figures are given in both cubic feet and pounds. With this data nearly every combustion problem is reduced to a simple problem in arithmetic, as is illustrated by the following examples.

Example No. 1. Find the theoretical air required to burn a fuel of 80 per cent carbon, 12 per cent hydrogen, 4 per cent sulphur, and 4 per cent inert by weight.

Using data from Column 10 of Table I for air requirements in cubic feet per pound of combustible,

For C — 0.80 × 151 = 121 cu. ft.
For H — 0.12 × 453.6 = 54.5 cu. ft.
For S — 0.04 × 57 = 2.3 cu. ft.

Total air = 177.8 cu. ft.

Using data from Column 12, Table I, for air requirements in pounds per pound of combustible,

For C — 0.80 × 11.48 lb. = 9.184 lb.
For H — 0.20 × 34.56 lb. = 4.15 lb.
For S — 0.04 × 4.35 lb. = 0.175 lb.

Total air = 13.509 lb.

Example No. 2. Find the weight of water formed in burning a gas, 70 per cent CH_4, 20 per cent C_2H_4, 5 per cent C_2H_6 and 5 per cent inert by volume, assuming perfect combustion.

Using data from Column 19, Table I, for H_2O per pound per cubic foot of combustible,

For CH_4 — 0.70 × 0.095 = 0.0665 lb.
For C_2H_4 — 0.20 × 0.096 = 0.0192 lb.
For C_2H_6 — 0.05 × 0.142 = 0.007 lb.

Total H_2O = 0.0927 lb.

Example No. 3. Find the dew point of the products in Example No. 2 at a pressure of 100 lb. per sq. in. ga. if there were 25 per cent excess air.

Using data from Column 8, Table I, for air requirements in pounds per cubic foot of combustible,

For CH_4 — 0.70 × 0.73 = 0.510 lb.
For C_2H_4 — 0.20 × 1.09 = 0.218 lb.
For C_2H_6 — 0.05 × 1.27 = 0.0635 lb.

Total air = 0.7925 lb.

With 25 per cent excess air, there would be 0.7925 × 1.25 or 0.992 lb. of air supplied for each cubic foot of fuel. The weight of the gas could be calculated from Column 4 but it would be about 0.050 lb. per cu. ft. which is assumed.[2] Then 0.992 lb. air supplied plus 0.050 lb. of gas gives a weight of 1.042 lb. for the total products of combustion. Then

$$\frac{\text{1.042 lb. of product}}{\text{0.0927 lb. water formed}}$$

gives a ratio of 11.2. From Fig. 1 this ratio gives a dew point of 214 deg. F. at 100 lb. ga. pressure.

The amount of water formed in burning a given fuel is always the same regardless of the amount of excess air for very little error is introduced by neglecting the amount of moisture in the air supplied. Even with saturated air at 70 deg. F. the error is only 1½ per cent. Thus it is possible to predict the dew point of the products whether it is furnace flue gas, or exhaust from an internal combustion engine.

If the composition of the fuel is given by weight and the CO_2 determined by an orsat, the total

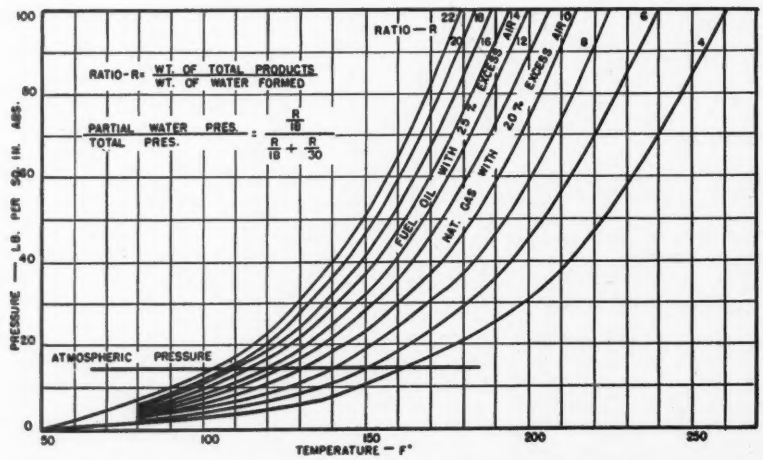

Fig. 1. Chart for determining the dew point of exhaust gases from the gas pressure and the ratio of the total products of combustion to the water vapor formed. The dew point is found at the intersection of the pressure line with the ratio curve, thus natural gas burned with 20 per cent excess air has a ratio of 10, and at atmospheric pressure the dew point would be about 132 deg. F.

[1] See Notes on Combustion Calculations by C. W. Messersmith, POWER PLANT ENGINEERING, p. 45, June, 1940 and p. 44, July, 1940; also Combustion, p. 41, March, 1940, Combustion Calculations Using the Mol by H. L. Norris, Jr.

[2] Calculation from Col. 4, Table I, shows 0.0485 lb. for the combustible portions totaling 95 per cent by volume. Assuming the 5 per cent of inerts to be nitrogen (specific wt. 0.078) this would add 0.0039 lb. making a total of 0.0524 lb. per cu. ft. of fuel. If the inerts were largely CO_2, which is a heavier gas, the specific wt. would be increased to 0.0557.

Table I. Data on the air and oxygen requirements for (top half), and products of (bottom half), perfect combustion for all common fuels. Figures are given on the basis of: (1) Cubic feet per cubic foot of fuel; (2) pounds per cubic foot of fuel; (3) cubic feet per lb. of fuel, and (4) pounds per pound of fuel. Numbers shown in bold face type are hypothetical values based on gasified carbon. Volumetric values are for 60 deg. F. and 14.7 lb. per sq. in. abs. pressure. In Col. 2, the values for carbon and sulphur, marked * are, atomic not molecular weights. In Cols. 22 and 26 the two values for sulphur, marked † are for SO_2 not CO_2

Fuel Characteristics					Requirements for Perfect Combustion per Cu. Ft. (or Lb.) of Fuel								
NAME	Chem. Symbol	Mol. wt.	% C by wt.	Cu. Ft. per lb.	Cu. Ft. O_2	Cu. Ft. Air	Lbs. O_2	Cu. Ft. Air	Cu. Ft. O_2	Lb. Air	Lb. O_2	Lb. Air	B.t.u. Per Lb. of fuel
Column	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Hydrogen	H_2	2	0	189.5	0.5	2.39	.042	.182	96	453	8.0	34.56	62,000
2. Carbon (to CO)	C	12*	100	**15.8**	**.5**	**2.39**	**.083**	**.382**	16	75.5	1.3	5.74	4,430
3. Carbon (to CO_2)	C	12*	100	**15.8**	**1.0**	**4.78**	**.178**	**.764**	32	151	2.7	11.48	14,540
4. CO to CO_2	CO	28	43	13.54	.5	2.39	.042	.183	6.8	32.4	.57	2.47	4,380
5. Sulfur	S	32*	0	....	..	...	...	...	12	57	1.0	4.35	4,050
6. Methane	CH_4	16	75	23.69	2.0	9.57	.169	.73	48	227	4.0	17.2	23,850
7. Acetylene	C_2H_2	26	92	14.58	2.5	11.96	.21	.91	37	174	3.1	13.3	21,460
8. Ethylene	C_2H_4	28	86	13.54	3.0	14.35	.25	1.09	41	194	3.4	14.8	21,450
9. Ethane	C_2H_6	30	80	12.64	3.5	16.73	.293	1.27	45	211	3.7	16.1	22,230
10. Gasoline	C_8H_{18}	114	84	3.33	12.5	59.81	1.04	4.52	42	199	3.5	15.11	20,542
11. Natural Gas	....	18.4	74	21.4	2.1	10.1	.178	.775	46	215	3.8	16.5	22,600

FUEL	Products of Combustion per Cu. Ft. (or Lb.) of Fuel															
	Cu. Ft.			Cu. Ft.	Lbs.				Cu. Ft.		Per Cu. Ft. (or Lb.)			Lb.	Lb.	
Name	CO_2	H_4O_2	N_2	Total	CO_2	H_2O	N_2	Total	CO_2	H_2O	N_2	Total	CO_2	H_2O	N_2	Total
Column	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1. Hydrogen	...	1.0	1.89	2.89	...	.048	.140	.188	...	189.0	356	549.0	..	9.00	26.56	35.56
2. Carbon (to CO)	1.0	..	1.89	2.89	.074	...	.139	.213	31.6	...	60	91.6	2.3	...	4.41	6.74
3. Carbon (to CO_2)	1.0	..	3.78	4.78	.114	...	.279	.393	31.6	...	120	151.0	3.7	...	8.81	12.48
4. CO to CO_2	1.0	..	1.89	2.89	.116	...	.139	.255	13.5	...	25.8	39.3	1.6	...	1.90	3.47
5. Sulfur	..	..	...	...	...	...	...	...	11.6†	...	45.2	56.0	2.0†	...	3.35	5.35
6. Methane	1.0	2.0	7.56	10.56	.118	.095	.360	.775	23.7	47.4	178	250.0	2.8	2.25	13.23	18.23
7. Acetylene	2.0	1.0	9.45	12.45	.232	.048	.700	.98	29.2	14.6	138	182.0	3.38	.69	10.2	14.25
8. Ethylene	2.0	2.0	11.34	15.34	.233	.096	.838	1.167	27.0	27.0	153	207.0	3.14	1.3	11.34	15.77
9. Ethane	2.0	3.0	13.23	18.23	.232	.142	.970	1.34	25.3	37.9	168	231.0	2.93	1.8	12.35	17.08
10. Gasoline	8.0	9.0	47.25	64.25	.927	.425	3.48	4.732	26.6	29.8	167	214.0	3.09	1.4	11.60	16.11
11. Nat. Gas	1.1	2.05	8.0	11.15	.126	.098	.590	.814	23.2	43.5	170	237.0	2.72	2.1	12.60	17.39

weight of gases is easier calculated by the formula

Total weight of products per pound fuel =

$$\frac{\%\text{ C by wt.}}{100}\times\left[\frac{240}{\%\text{ }CO_2\text{ by vol.}}+1\right]+9\left[\frac{\%\text{ H by wt.}}{100}\right]$$

Substituting values of: C = 75 per cent; H = 20 per cent, and an orsat reading of 10 per cent (approximating the conditions of Example Nos. 2 and 3[3]), calculations are, for the weight of the products of combustion per pound of fuel

$$0.75\left[\frac{240}{10}+1\right]+[9\times 0.20]=20.6$$

In this the weight of the water is equal to the last term or (9 × 0.20) which gives 1.8 lb. of water per lb. of fuel. Also 20.6/1.8 gives a ratio of 11.4+, practically the same as in Example No. 3.

From Fig. 1 it may be seen that for the most part the dew point of the flue gases will fall between 125 and 150 deg. F. and one might ask "Why the worry about dew points as low as these." This writer has found that, with short stacks preceded by induced draft fans discharging at high velocity, there has been no serious trouble with corrosion or rust. The trouble comes not from low stack temperatures but from long passages and low velocities.

Low flue gas velocities seem to allow a surface layer approaching zero velocity and this layer reaches a temperature far below the main stream average. Common practice is to set the practical lower limit at about 270 deg. F. or 70 to 100 deg. higher than the dew point. Either figure gives a conservative temperature gradient that should prohibit water formation on the stack walls. Water alone is of little consequence, but it dissolves the oxides to form acids such as sulphurous or carbonic, either of which will etch steel. In general the higher the sulphur content of the fuel the higher the stack temperature should be kept.

Internal Combustion Engines

This article is more particularly concerned with the problems of condensation in the internal combustion engine. In the lubrication of steam engines, condensation has long been known to aggravate wear, but in the case of the "fire" engines this matter has for the most part been overlooked, perhaps, because it is hard to imagine condensation occurring in a gasoline engine. However, Table I, Column 27 shows that for each pound of gasoline burned there are 1.4 lb. of water formed. A natural gas engine using 10 cu. ft. of gas per horsepower hour can make 1 lb. of water each hour of operation for each horsepower developed! At any rate, plenty of water vapor is formed and the present trend is to place a good part of the responsibility for cylinder wear on to the condensation of part of that water vapor.

If it is assumed that condensation is a major factor, then the water must be formed in sufficient quantities to: (1) wash the walls free of oil; (2) coat the walls so the oil may not stick; or (3) dissolve the oxides to form a corrosive acid.

This being the case it would appear that the greatest wear would be at the bottom of the

[3]Note that here the fuel analysis is by weight while in Example 2 it is by volume.

stroke where there is the greatest motion, the coolest walls, the lowest temperature, and relatively high pressures. On the contrary, maximum wear is at the top (this writer does not mean to overlook the point that this is also the hardest to supply with oil). Now if the temperature at this point is too high for condensation during the power stroke it is highly possible that the most wear occurs during the compression. When one remembers that the unscavenged "spent" gas is saturated and there is further cooling due to the admission of cold (and sometimes washed) air the idea becomes more plausible.

All during compression there is a constant liberation of heat and an increase in pressure so the later on the compression stroke: the more water; the more acid; the more sludge; and, the less protective oil. This theory logically explains the heavy wear at the top of the stroke which might be better classed as corrosion so as to imply both chemical and physical reaction. To help support the chemical reaction idea it has been demonstrated that the wear bears a distinct and direct relation to: (1) the sulphur in the fuel; (2) the hydrogen in the fuel; and (3) an inverse relation to the jacket water temperature.

From Fig. 1[4] it will be seen that at over 180 deg. F. the curves break sharply, so that, any time during the cycle that the heat liberated is less than the heat transfer through the walls, there can be condensation. The immediate remedy appears to be in (1) filtered dry air; (2) burning low sulfur and hydrogen fuels; and (3) raising the jacket temperatures.

Wet air may have anti-knock qualities that offset the possible reduction in wear; the consumer can't always be choosy about the fuel; so raising of the jacket temperature is highly recommended. And don't worry about the oil for it has been demonstrated that the oil is less likely to sludge, become acid, or dirty in appearance under these conditions. In all probability there will be less cylinder wear. Further, there may be a decrease in heat rate due to the utilization of waste heat at higher levels.[5] Remember also that an internal combustion engine is still a heat engine and that it is poor economy to make a condenser out of it.

Final temperatures at the jacket water outlet depend somewhat on the size and service of the engine. An engine that is started frequently may have "growing pains" if brought up to high temperature each time it is started. On large engines it may be desirable to keep the jackets at a low temperature simply as a matter of operating comfort and convenience. Again, with some waters, low temperatures may be desirable to stop precipitation of carbonate scale in the jackets or heat exchangers.

Regardless of the temperatures used, the quantity of cooling water should be maintained reasonably constant, for if the flow is reduced materially, starved passages and extreme localized heating may result. Usually the temperature rise is held to about 20 deg. F. whether the temperature range be 120 to 140 or 190 to 210 deg. F.

A short circuit bypass in the cooling system piping may be advisable to give the necessary temperature control facilities. Thermometers are necessary for the operators' sense of feeling can never be relied upon even in the lower temperature range. While the high temperature may not always be advisable due to one or more of the local conditions mentioned above, it has been the writer's experience that practical higher jacket water temperatures will reduce cylinder wear and pay lubrication dividends.

[4]Other references exclusive of notes made by the author over a period of 6 yr. operation of Diesel, gas and steam plant operation are: Private correspondence with Socony-Vacuum Oil Co.; Power, No B.t.u's Lost, Jan., 1940, and New Gas Engine Heat Recovery, March, 1940; for the dew point formula Kent's Handbook, Volume 1; for the combustion formula Principles of Combustion by Pratt.

[5]Better Waste Heat Recovery, POWER PLANT ENGINEERING, p. 65, March, 1940.

Lubrication of High-Speed Diesels

Because of their characteristic conditions of operation, Diesel engines subject the lubricating oils they use to extremely severe conditions which tend to break them down by oxidation causing sludge, gum and other contaminants. The author describes how these failures take place and how they may be averted by compounding the straight mineral oil with materials that inhibit oxidation and resist heat

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DIESEL engines, because of their design, are just about the best possible set-up for oxidizing lubricating oil. Heat and air are the major enemies of lubricating oil, and the more heat that is applied to an oil in the presence of air the greater is its tendency to oxidize and form sludge, gum and other contaminants.

In a Diesel engine, temperatures at the end of the compression stroke are much higher due to greater compression pressures. These pressures average 450 to 550 lb. per sq. in. In general, there is an increase in temperature above atmospheric of about 2 deg. F. for each pound increase in compression pressure. Thus, 500 lb. compression in a Diesel engine would generate a temperature of about 1000 deg. F.

The maximum temperature at the top of the Diesel piston is about 700 deg. F. The temperature of the top compression ring generally ranges from 475 to 490 deg. F. and in the four-compression-ring type piston the temperature of the bottom compression ring will be around 380 deg. F. The rate of oxidation roughly doubles with each 20 deg. F. increase in temperature. Thus, the high speed Diesel inherently subjects the lubricating oil to as much as sixteen times the oxidation tendency of a spark ignition engine.

Furthermore, the Diesel always operates with excess air (oxygen). In the throttle control type of engine a full charge of air is fed into the cylinders only when the engine is under maximum load and as a result there is normally little or no excess oxygen in the gas mixture after combustion or in the blow-by gases. Diesels, however, compress a

maximum amount of air at all loads and excess oxygen is always present; in fact, Diesel blow-by generally contains about 90 per cent air.

Due to these severe operating conditions, contaminating deposits resulting from deterioration of the lubricating oil are generally formed at a comparatively high rate in Diesels. These deposits form and stay in place on the hot metal surfaces or are carried in the oil stream. Efficient filters will remove the latter, but the former interfere with proper piston operation, affecting both oil distribution and engine compression. Such deposits tend to collect behind and around the rings and also clog the oil grooves or holes through which the lubricating oil is supposed to return to the crankcase.

Another adverse effect of such deposits is their interference with heat transfer. In all types of internal combustion engines a major portion of the heat absorbed by the head of the piston is passed off through the rings to the oil film, through the oil film to the cylinder wall or the cylinder liner, and then into the cooling water. Any deposits collecting around the rings will interfere seriously with this necessary heat transfer, resulting in further increase in piston temperatures, which, in turn, increase the tendency of the lubricating oil to oxidize and form additional deposits. The ultimate result of this process is stuck rings, large power loss, high blow-by, piston drag, etc., all of which mean overhaul and repair expense. Possible increased use of cast iron pistons to replace aluminum may also aggravate this tendency due to inherently poorer heat transfer.

Another source of deposits in Diesel engines is the formation of carbonaceous particles resulting from incomplete fuel combustion. During the exhaust stroke, such particles are present around the top of the piston and, because of the high pressure (around 500 lb.) during the compression and power strokes some of these particles are forced back of and around the rings. Such deposits are in addition to those described above from lubricating oil and aggravate the situation outlined. The 2-cycle Diesel engine equipped with superchargers, due to its more effective scavenging, generally experiences less trouble from such particles than the conventional 4-cycle Diesel.

Crankcase oil temperatures in Diesels reflect the more severe temperature conditions in the cylinder area, and frequently reach 240-250 deg. F. Preferred crankcase oil temperatures are about 180 deg. F., high enough to insure good fluidity and freedom from "cold" sludge due to water condensation and yet not so high as to increase oxidation unduly. Various methods can be used to keep the crankcase oil temperature down, such as provision for greater crankcase capacity, oil coolers, etc. However, it should not be inferred that maintenance of crankcase oil temperatures at 180-200 deg. F. will insure satisfactory Diesel lubrication, as this has only a very minor effect on oil temperatures in the critical upper cylinder area. To illustrate, oxidation conditions on the lubricating oil are about 65,000 times as great at 500 as at 180 deg. F.

Straight Mineral Lubricating Oils

A lubricating oil has three major functions in an internal combustion engine—to lubricate, cool and seal. The performance of these functions may be seriously affected by the presence of contaminants from outside or within the engine. Outside contaminants may come from the intake air or from faulty combustion. Such contamination can be controlled by proper filtering, proper type of fuel, ignition, and correct mechanical adjustments. These factors have no direct relation to the lubricating oil proper.

The characteristics which the lubricating oil itself possesses in order satisfactorily to lubricate high speed Diesels are, briefly, maximum ability to resist deterioration due to contact with heat and oxygen and maximum ability to stay on very hot metal surfaces. In addition, the oil must, of course, have the correct viscosity, low carbon content and low pour point.

Even the best straight mineral oil available today will not meet these requirements adequately. There has been a great advance during recent years in the technology of manufacturing lubricating oils, and the oils produced today in a modern refinery are infinitely superior in quality to those available a few years ago. Nevertheless, such straight mineral oils, while very much superior in oxidation resistance and in ability to lubricate hot metal surfaces than formerly, still do not come up to modern requirements on these points for the present day high speed Diesel engine. In March, 1939, after 3 yr. of intensive research, the Standard Oil Co. of California introduced the first compounded Diesel engine lubricating oil for use with any type of bearing.

The type of compounding generally used in industrial oils consists of animal or vegetable fats and acids or occasionally lead, sulfur and chlorine compounds. These are incorporated to increase such characteristics as oiliness, tenacity, film strength, etc., of oils used in steam cylinders, bearings, gears, and similar services. However, it is obvious that none of these conventional compounding agents would be satisfactory under the high temperature and severe oxidizing conditions encountered in Diesel engine cylinders and bearings. An entirely new type of compounding had to be found.

This new type of compounding utilizes metallic "soaps". It is not a single chemical compound, but rather a complex mixture of several compounds, each of which has been chosen for the effect it will have on the whole. The very fact that many years went into its development indicates that it must be carefully matched to the type of base oil employed. Naturally, the most suitable type of oil is chosen as a base.

Many compounds which are non-corrosive when used with one base oil may become quite corrosive if employed with some other oil. Furthermore, due to the different chemical nature of compoundings used by various manufacturers, mixing of different types of compounded oils should be avoided.

This compounding material works, in the first place, as an excellent anti-oxidant. This means it helps the lubricating oil base further to resist deterioration from heat and oxygen, thereby minimizing the formation of deposits in the engine interior. Secondly, it increases greatly the ability of the compounded oil to stay on very hot metal surfaces. Thirdly, it has a decided "detergent" action which results in keeping the engine cleaner than ever before.

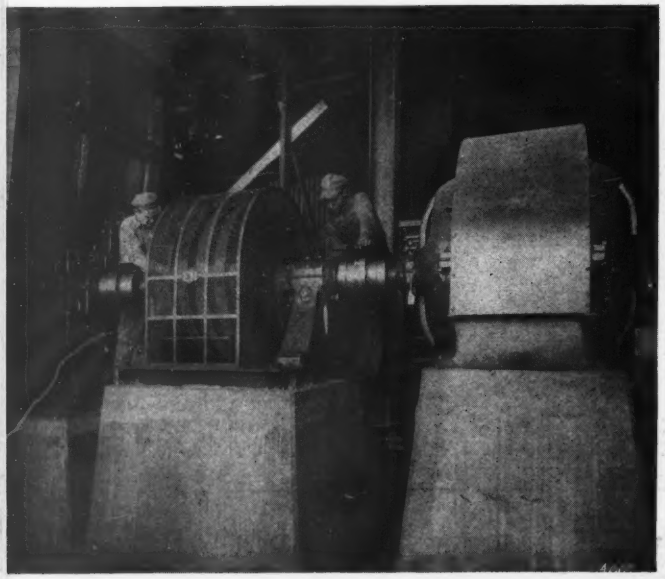
This oil is said to have a "detergent" action because the compounding literally acts like a cleansing soap (detergent) in carrying away dirty deposits from engine surfaces. It must be realized that any lubricating oil, even the best type of compounded oil, still will deteriorate slightly under Diesel engine conditions. Therefore, detergent action is necessary to clean out deposits from other

(Continued on Page 110)

PICTURES of Engineering

What goes up, must come down. Sometimes a long interval exists between the "going up" and the "coming down," but this does not alter the fundamental truth of the statement. As shown by the photograph at the left, the huge brick power-house stack at the Clipse Works of the Atlantic Refining Company at Franklin, Pa., came down in a dense cloud of dust when 50 lb. of dynamite, embedded in its base, was set off, blasting away a section of the foundation. The 76 yr. old plant was abandoned 4 yr. ago and its demolition is, now, nearly complete. The tall stack, believed to be the largest brick structure of its kind in the United States was built in 1916. It was 310 ft. high, 83 ft. in circumference at the base and 15 ft. in diameter at the top. Expert dynamiters used 30 additional pounds of dynamite in four preliminary blasts to weaken the foundation so the final blast would down the stack

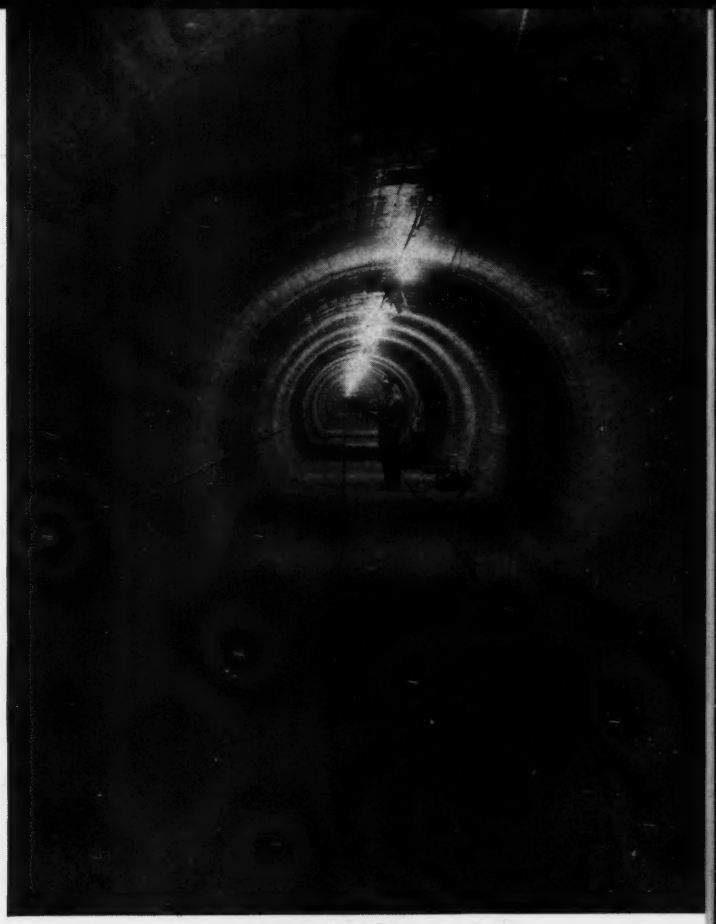
Extra protection at G. E. Nine elevated guard houses like the one shown in the photograph at the right have been installed outside General Electric's Schenectady Works to afford better plant protection. At the top of each house is an 18 in., 1500 watt searchlight, specially designed by the company for protective lighting purposes. A supplement to fixed protective lighting encircling the works, the searchlights can be turned in all directions as needed

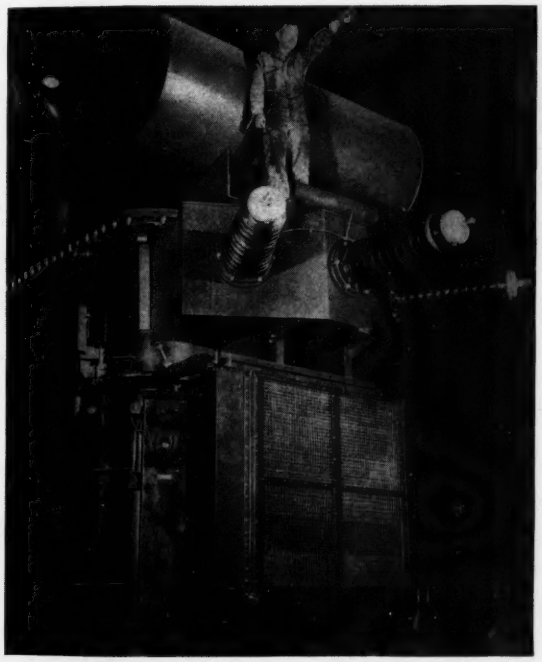


Left. Workmen are shown completing the installation of a magnetic drive on the induced draft fan of No. 4 boiler in the Canal Station of the Louisville Gas and Electric Co., Louisville, Ky. This is one of six such units recently ordered by this utility from the Electric Machinery Mfg. Co. This one is rated, 752-hp., 1164/180 r.p.m. and is driven by an 800-hp., 1200 r.p.m., 2300 v. motor

Interest

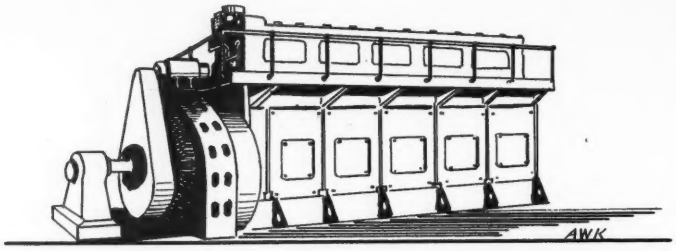
No! the view at the right is not a view of the new Chicago subway. It is merely a view of the tunnel through the heart of Grand Coulee Dam to carry the electrical lines that will someday join the dam's two big powerhouses into a common network. It is two-thirds of a mile long and 12 ft. in diameter. Conduits have been imbedded in the concrete floor and cable trays on which some of the cables will rest will be erected along the walls. The track in the floor will be used by a flatcar carrying cable reels to facilitate stringing the heavy conductors. Because of war needs construction of the east power house is considered





Mobile Power Transformers. The photograph at the left shows the first of six new type mobile power transformers rated 15,000 kv-a. maximum capacity being constructed by the General Electric Company at its Pittsfield, Massachusetts works for the American Gas and Electric Co. Each of these units will be mounted on a specially designed railroad car so that it can be transported readily to any locality on the company's system where there may be a need

A wide variety of electrical equipment in the Mellon National Gallery of Art in Washington, D. C., typifies the latest practices in large buildings. Special arrangements of floodlights give daylight effects without highlight or shadow. The center basement scene at the right shows the dead front AB "De-ion" low voltage electrical distribution board installed by Westinghouse. These breakers have capacities ranging from 60 amp. to 600 amp. On the right is seen a 400 hp. type CW. Westinghouse slip-ring, 1800 r.p.m. motor direct connected, through gearing, to a Worthington high-speed centrifugal compressor. The electrical installation includes transformer vaults for six 750-kw. and three 1000-kw. network transformers and protectors, each in 3-phase, 60 cycle operation, 5 per cent impedance



Inspection Procedure *for* DIESEL ENGINES

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SINCE the procedure to be followed in making any inspection will vary with the type of equipment involved, this consideration of Diesel engine inspection is confined largely to the inspection of the principal moving parts of slow speed, heavy duty type of engines, the type most frequently found in severe industrial and power service.

The recommended procedure that follows is based upon a complete investigation of conditions and alinement. Nothing is taken for granted. It will be noted that no repairing or refitting methods are discussed. It is assumed, however, that repairs will be made as and when inspections reveal irregularities.

Since the complete inspection of a Diesel engine is a proceeding involving much attention to detail, this description will be presented in two parts, this first part dealing with the crankshaft and main bearings, while the second part, to be presented in a subsequent issue, will discuss inspection of the cylinder or liner, the pistons, connecting rods and other moving parts of the engine.

Perhaps the first question to be considered is that of the operating period between inspections. Many factors govern the elapsed running time. The following list indicates a few of the more important ones.

1. Load factor.
2. Fuel.
3. Frequency of starting and stopping.
4. Operating conditions, dust, etc.
5. Program of running repairs.
6. Lubricating oil.

The procedure involved in the inspection of Diesel engines is dependent upon the type and size of the engine. As pointed out by the author, this discussion applies to the slow speed heavy duty engines used in severe industrial service. It is presented with the thought of offering one proven procedure for making a few of the more important inspections incident to Diesel engine maintenance. This article was first presented as one of the papers at the National Meeting of the Oil and Gas Power Division of the American Society of Mechanical Engineers held at Kansas City, Mo. It will be presented here in two parts, this first part dealing with the crankshaft and main bearings. The second part to be presented in a subsequent issue will take up the inspection of cylinders, pistons, connecting rods, and other moving parts of the engine

Naturally, the only sound basis on which this period can be determined is past performance under a given set of conditions. It might be said, however, that under average conditions these heavy duty, slow speed engines can be kept in good condition by inspection and overhauling every 8000 to 10,000 hr. of operation.

Assuming that the engine is now ready for this periodic inspection, attention is turned to the task of examining some of its major parts.

Alinement and Condition of Crankshaft

After the engine has been dismantled and cleaned up, the alinement and condition of the crankshaft is one of the inspector's first concerns. Remove each main bearing cap and carefully check for such mechanical defects as loose babbitt, cracks, evidence of wear or other improper operation. In a similar manner, inspect each lower shell as it is removed, replacing each, in turn, as required for shaft support. In the event that the condition of any of these bearings requires repairs, they should be sent to the shop at once. This done, suspend the shaft on two lower bearing shells. See that the shells are so located that the shaft will be balanced; i. e., endeavor to make the

overhanging ends about equal and their sum as near equal to that portion between the supports as practical. While suspended in this manner, make thorough inspection of shaft for defects, injuries and wear. Perhaps the first step should be an examination for cracks. The origin of cracks will usually be found in or near fillets, holes or other points of abrupt section change. Paint all suspicious portions of the shaft with a mixture of chalk and alcohol. Rotate the painted shaft to allow any crack present to give up entrapped oil which in turn will discolor the chalk. In the case of large heavy shafts, difficult to rotate, it may be advisable to bump it with a wooden ram in order to set up a vibration that will aid in the liberation of the trapped oil. Needless to say, that in case cracks are found, the shaft should be removed and repaired.

Following the inspection for cracks, examine each crank pin and journal for scores, rough spots and other evidence of undue wear. With the use of calipers and micrometers, determine the amount of taper and out-of-round. Barring accidents, the wear on main journals is usually quite uniform. Due to inaccurate machining and consequent misalinement in many of the older engines, tapered crank pins are often found. This is not serious, provided the taper is uniform and the bearing is fitted properly. The matter of flat spots does, however, become a real problem. A crank pin five ten-thousandths inch (0.0005) per inch of diameter flat will produce a noticeable noise. The maximum flat or out-of-round allowable in any instance will depend upon the owner's evaluation of noise and the accelerated wear on affected parts, although attention should be given to truing up the pin when the out-of-round wear becomes as much as one thousandth (0.001) to fifteen ten-thousandths inch (0.0015) per inch of shaft diameter. It may be necessary to move the shaft supports during this examination to permit inspection of all journals.

Use of Dial Gages

The inspector is now ready to check the shaft for any indication of permanent deformation. This work can be greatly facilitated by the use of dial gages in sufficient number to place one gage over each suspended journal. Securely fix these gages in a position where the operating point will rest on the very top of the respective journals.

Set all dial gages on zero and slowly revolve the shaft several times. Observe any appreciable deflection of the indicator hands. Now set the No. 1 crank pin on top center, reset all gages to zero and again slowly rotate the crankshaft. Stop shaft on each quarter position of No. 1 crank pin and read all gages. If there is still no evidence of permanent deformation, rotate the shaft and take readings once more as a check on original observations.

If, on the other hand, the gage readings indicate a kink in the shaft, further investigation is required. With the aid of previous readings, slowly rotate the shaft and determine the position of No. 1 crank pin when affected gages indicate maximum reading. Thus, the deformation or bend is in its extreme top or bottom position. Its position with respect to the No. 1 crank pin can be readily determined by the use of a protractor. Again reset all gages and slowly rotate the shaft as before, stopping the shaft to read gages at 90 deg., 180 deg. and 270 deg. of rotation. Repeat the procedure until consistent readings are procured.

Obviously some means must be employed to intelligently record the various readings. An example of one system commonly used is shown on A in the accompanying diagram. The circles are first drawn to represent each journal. The position of the No. 1 crank pin is accurately located on the periphery of the circle with the reading placed adjacent. One set of circles may be used for several trials or a new set may be used for each trial as desired.

The longitudinal location of the deformation may be located with fair accuracy by the application of the principle of similar triangles or graphically as shown in B in the diagram. Regardless of which method is used, it is necessary to accurately measure and record the horizontal distance between respective dial gage positions.

In special cases, it may be desirable to change the location of one or both supporting shells and repeat the entire procedure as a check on the original investigation.

The foregoing discussion deals primarily with shafts having a simple bend. Very often shafts are found with more complicated damages. In such cases, the condition will be determined by the application of principles outlined above to the individual case.

The permissible amount of deformation is a question subject to much discussion. It is recommended, however, that proper steps be taken to straighten the shaft if it indicates a total deformation of more than two thousandths inch (0.002) plus four ten-thousandths inch (0.0004) per inch of shaft diameter.

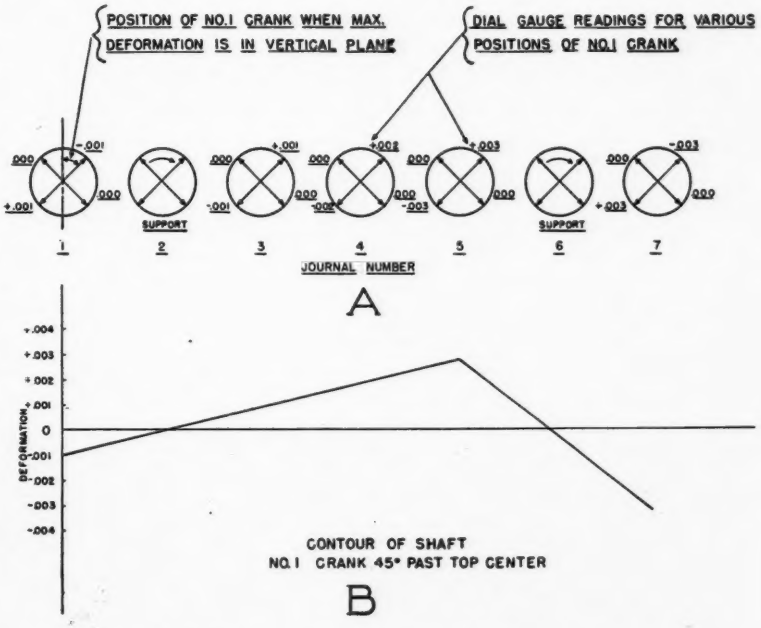


Fig. 1. Diagram used to determine crankshaft deformation

Replace all the lower main bearing shells in the exact location from which they were removed. When centrally located, block each shell in place so that the shaft can be rotated without shell movement. Lubricate each journal so that a continuous oil film is procured.

Alining the Shaft

The shaft is now ready for alinement. Bridge gage readings and crank web deflection should be made simultaneously or at least in conjunction with each other. In case there is no bridge gage available, spot the frame directly above the top of the journal. Measurements may then be taken from this permanent reference point to the top of shaft with inside micrometers. However, for the purpose of this discussion, the use of a conventional bridge gage is assumed. Other instruments and equipment required for checking alinement will be a strain gage and two special jacks, or clamps, for the purpose of clamping the shaft down into the bearing shell.

With this necessary equipment, proceed as follows: Place the No. 1 crank pin in its top center position and install strain gage near center line through main journals. Revolve the gage several times to make sure of accurate reading, then set dial on zero. Before moving the shaft, take a bridge gage reading of the journal on either side of the crank throw in question. Rotate the shaft in the direction of normal operation. Stop the shaft at each quarter position and record strain gage and bridge gage reading. The bridge gage readings on all four quarters are merely for check purposes as these readings will be the same after the "out-of-round" value has been considered. Repeat the above procedure except press the shaft down to a solid bed in both main bearing shells (one on either side of crank throw in question) when the crank pin is in its extreme top and bottom position with a jack or other clamping device.

There should not be more than two thousandths inch (0.002) difference in the bridge gage reading of either journal when the shaft is free and when it is clamped. If this reading is more than the prescribed two thousandths inch (0.002), it may be assumed that the particular bearing is lower than the adjacent ones. Obviously, the bridge gage reading will be but little value in determining high bearings. In fact, these readings are to be used more as an aid in interpreting strain gage measurements than as an independent indication.

Repeat this procedure with each crank throw. This completed, use an approved shafting level and check the slope of each main journal and that of the adjacent main frame. The levels thus obtained are not only indicative of the shaft contour but are quite useful as an additional check on the strain gage readings. If there is evidence of misalinement, the best plan to follow is to make a sketch of the shaft showing levels and maximum deflections. A study of this sketch will indicate quite clearly the location of high or low bearings. From the information thus obtained, a skilled mechanic can scrape high bearings down to procure proper alinement. Obviously, all high bearings must be lowered to the low bearing level or the low bearing must be raised by rebabbitting. Flat spots, taper, out-of-round, etc., should always be kept in mind when interpreting all crankshaft measurements.

Good practice indicates that crank web deflection should be held below a maximum of two thousandths inch (0.002). On first thought, it may seem rather inconsistent to use a single value, two thousandths inch (0.002), as a maximum deflection for all heavy duty crankshafts. However, since the shorter stroke shafts are usually designed with thinner web sections, the actual variation of stress will be small with any given deflection. In any case, the fiber stress in the shaft will be far below the extreme limit stress prescribed by many insurance companies when the deflection is held to two thousandths inch (0.002) or less.

It is quite difficult to separate the inspection and the adjustment of main bearings. These subjects will, therefore, be discussed together for the sake of clarity.

Inspection and Adjustment of Main Bearings

If the previous inspection of these parts has revealed an uneven or poor bearing surface, blue the shaft and place the bearing cap in place with just enough shims to keep it from gripping the shaft so it will not turn. Pull down the bearing bolts evenly and with proper tension (never use sledge), then rotate the shaft. This will indicate high spots on the bearing which can be relieved in an approved manner. The above method of fitting main bearings will eliminate the possibility of scraping the bearing bore of a bearing out of parallel with the shim surfaces. Do not set a bearing on top of a shaft as a means of determining its surface condition. If the bearing has

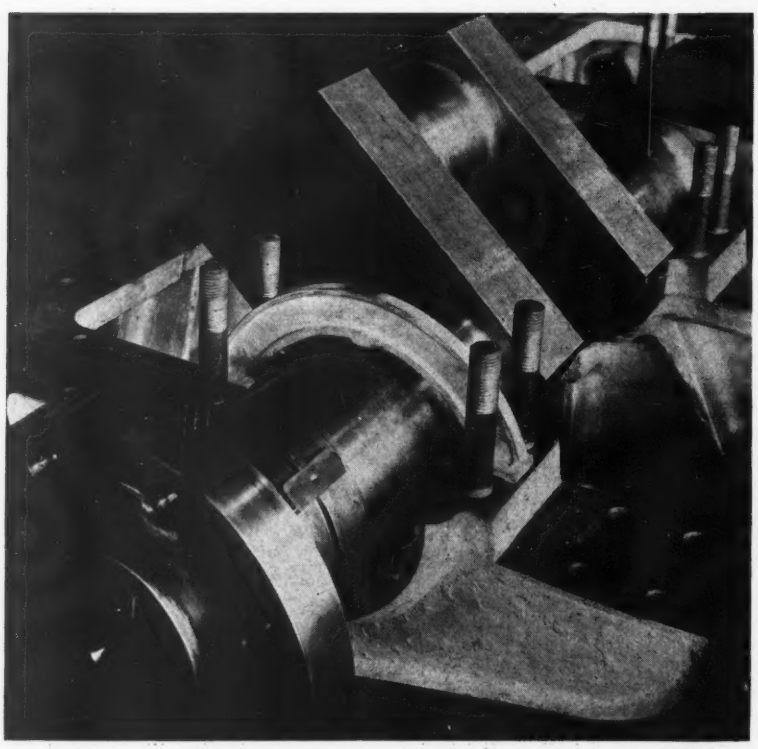


Fig. 2. Showing the use of the bridge gage

been fitted properly, the adjustment will be simple. Add to the shims used for the last bluing, the proper amount of clearance. Replace the caps and tighten bolts evenly and without undue strain. In the event, however, that it has not been necessary to do more than simply adjust the clearance, an easier method of adjustment may be followed. Replace the original shims and place lead wire over the top half of the journal. The number of leads to be used will vary according to the length of the bearing. Usually from two to four wires will suffice. The lead wire should be soft and the diameter not more than twice the normal clearance. Three-ampere fuse wire serves the purpose very well. With the wire in place, install the cap and tighten the bearing bolts. Remove the wires and determine maximum thickness which, of course, represents existing clearance. Reduce shim thickness the required amount and reassemble the bearing.

Regardless of which method is used to adjust clearance, the shaft should be rotated after each setting of each bearing. The fitted and adjusted bearing caps should not add any appreciable drag on the shaft. The usual clearance allowed main bearings is five ten thousandths inch (.0005) per inch of shaft diameter plus two-thousandths inch (.002).

With the shaft and bearings properly adjusted and passing all of the inspection, the shaft should roll freely and give another 10,000 hr. of trouble free operation under full load conditions.

MANAGERS of Britain's war factories are discovering that the women now coming into their works from shops, offices, the professions and private life, have very definite likes and dislikes.

Welding is a job that many women are turning to now, but even here there are two distinct camps, those who like the fireworks of electric arc welding and those who prefer fusion welding.

But in one important British factory fusion welding has been made much simpler and more effective by a new process which eliminates the usual defects. Its main feature is the application of a controlled temperature applied before and during either a manual or a machine weld. Other features prevent the formation of gas crevices or pockets. Formerly, in spite of X-ray examination, weaknesses were liable to occur, and could be detected only in mechanical tests.

POWER OUTPUT SOARS FROM WAR IMPETUS

(Continued from Page 53)

depend upon the availability of materials and equipment. Extensions of service into new areas are prohibited under existing OPM orders except to serve defense projects, but government announcements indicate that these projects are to be greatly expanded. In view of OPM orders, distribution expenditures are expected to be sharply curtailed, but expenditures for generating stations should be 25 per cent heavier than in 1941.

Output of electricity in 1941 by all agencies contributing to the public supply totaled about 168 billion kw-hr., an increase of 16 per cent over that for the previous year. Fuels produced 115.6 billion, an increase of nearly 19 per cent, and water power produced 52.4 billion, an increase of 10 per cent over the previous year.

Record breaking drouths throughout the territory east of the Mississippi reduced output of hydroelectric plants in New England about 8 per cent, and, in the Middle Atlantic states about 5 per cent, below normal. In the Southeastern states stream flow was seriously reduced, but because more hydro generating capacity was in operation than during the previous year the net effect was only a 4 per cent reduction. In all other sections of the country the output of hydroelectric plants was above 1940.

Industrial and mining plants in 1941 are estimated to have produced about 40 billion kw-hr., making the grand total power output from all sources 208 billion kw-hr., compared with 143 billion in 1938 when the United States produced one-half as much electricity as all the rest of the world combined.

Electric customers of all classes was 31,553,000 at the close of 1941, an acquisition of 1,362,000 customers during the year, the greatest gain since 1927. Housing for defense workers caused much of this expansion. At the end of the year there were 2,350,000 farm customers, about two-thirds of whom are served by electric utility companies. Of the estimated 35,400,000 families in the United States, 27,000,000 or 76 per cent are now taking electric service.

Sales of refrigerators exceeded 3,500,000 units, or 800,000 more than were sold in 1940, the previous high figure, while sales of electric ranges reached 750,000 compared with 436,000 in the previous year. While these large purchases of electric appliances are not likely to be repeated in 1942 because of priorities and lack of stocks, those already installed constitute a substantial backlog for sustaining the level of domestic electric use for some years.

New low records were made in electric rates in 1941 and the average price of electricity for domestic service dropped to 3.73 ct. per kw-hr. as compared with 3.84 ct. the year before, and 5.78 ct. 10 yr. ago. The average residential customer used 986 kw-hr. during the year as compared with 952 kw-hr. in 1940. In 10 yr. the use of electricity per customer for household purposes has increased by 400 kw-hr.

Rates and Taxes

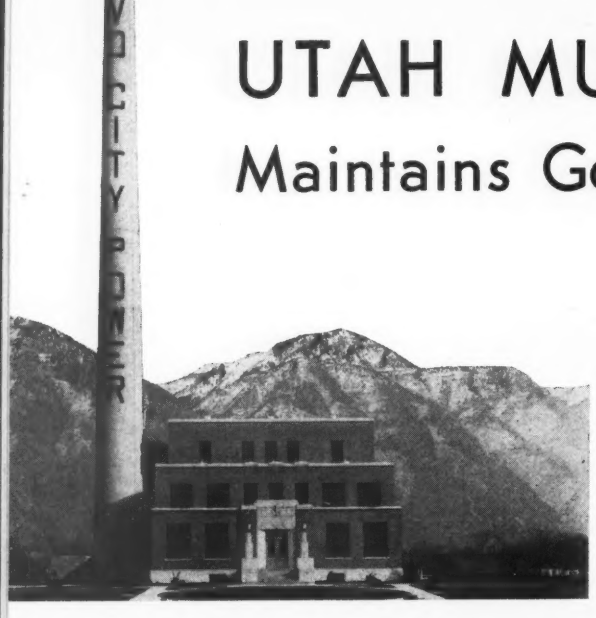
Total revenues of the private companies in 1941 approximated $2,490,000,000, an increase of 9.4 per cent over the year before. According to reports of the companies which have published them for 10 mo. of the year (with November and December estimated), operating expenses plus depreciation rose at about the same rate as revenues. Taxes, applicable to electric operations, increased by almost $100,000,000 from $413,000,000 in 1940 to $510,000,000 in 1941. This represents an increase of 23½ per cent. Taxes now consume 20½ ct. of every dollar collected from all consumers of electricity.

Composite income statements of the operating electric utility companies for 1941 will show a balance for common stocks and surplus of about $416,000,000 or about 2 per cent less than in 1940. The increase in gross earnings of about $213,000,000, as well as the decrease in interest charges of about $12,000,000, have all been absorbed in increased costs for operation and taxes. Taxes are greater than payrolls, and now exceed by 40 per cent the combined total of requirements for bond interest and preferred dividends.

Financing operations in 1941 were estimated at a total of $700,000,000 for the operating electric utility companies. This was substantially less than the $958,000,000 reported for the year before and the smallest since 1937, when $645,000,000 in securities were issued. Of the 1941 total, approximately $110,000,000 could be considered as new financing.

UTAH MUNICIPAL PLANT
Maintains Good Operating Record

By ROY W. BROWN, Chief Engineer
Department of Utilities, Provo, Utah

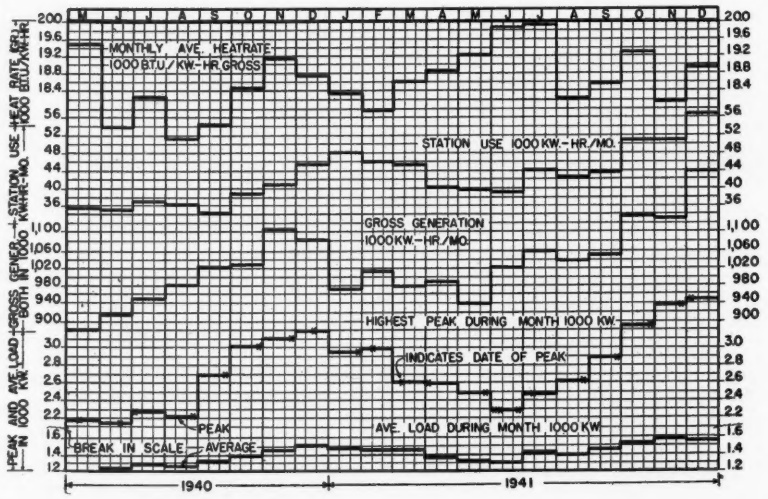


First section of municipal plant, with a capacity of 4000-kw. in two units, built in record time of 9 mo. and third unit of 2500-kw. capacty put in service the next year. Initial cost of completed station $111.27 per kw. of capacity; operating costs last year, including depreciation, averaged 7.42 mills per kw-hr. on the switchboard. Variable stroke, reciprocating boiler feed pumps cut auxiliary power consumption to approximately 4.5 per cent of gross power generation. Second plant with two 7500-kw. units contemplated in near future to meet increasing war needs in connection with the new $126,000,000 Columbia Steel Co. mill

AFTER SEVERAL YEARS of litigation with the local utility company, ground for the Provo Municipal power plant was broken August 1, 1939. Full load was first carried on the station April 21, 1940, less than 9 mo. after starting.

The station, with two 2000-kw. Elliott condensing turbines and two 25,000 lb. per hr., 450 lb., 725 deg. F. Combustion Engineering chain grate stoker fired boilers, was designed for the future installation of a third boiler and turbine. From the first the monthly load peak never went below 2100-kw. and increased so rapidly in the fall of 1940 that it was decided to install the third unit immediately.

This 2500-kw. unit went into service the latter part of July,


M J J A S O N D J F M A M J J A S O N D
MONTHLY AVE. HEATRATE 1000 BTU/KW-HR GROSS
STATION USE 1000 KW.-HR./MO.
GROSS GENERATION 1000 KW.-HR./MO.
HIGHEST PEAK DURING MONTH 1000 KW.
INDICATES DATE OF PEAK
AVE. LOAD DURING MONTH 1000 KW.
PEAK
AVERAGE
BREAK IN SCALE
1940
1941
HEAT RATE BTU/KWH-HR
STATION USE 1000 KWH-MO.
GROSS GENER. BOTH SETS 1000 KWH-MO.
PEAK AND AVE. LOAD 1000 KW.

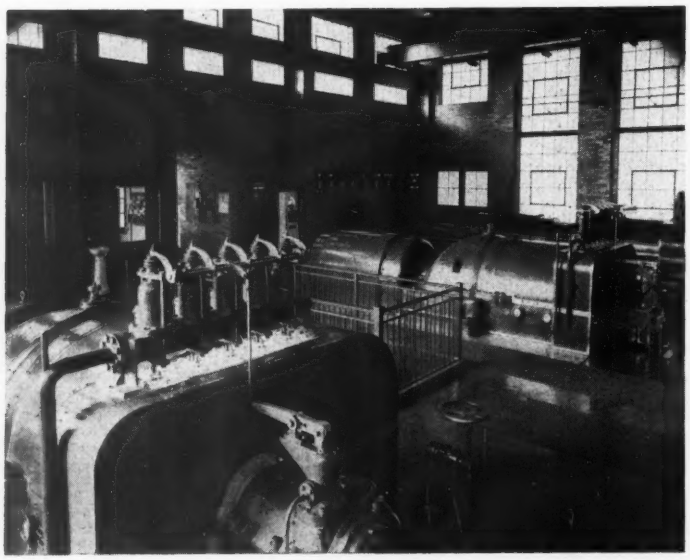


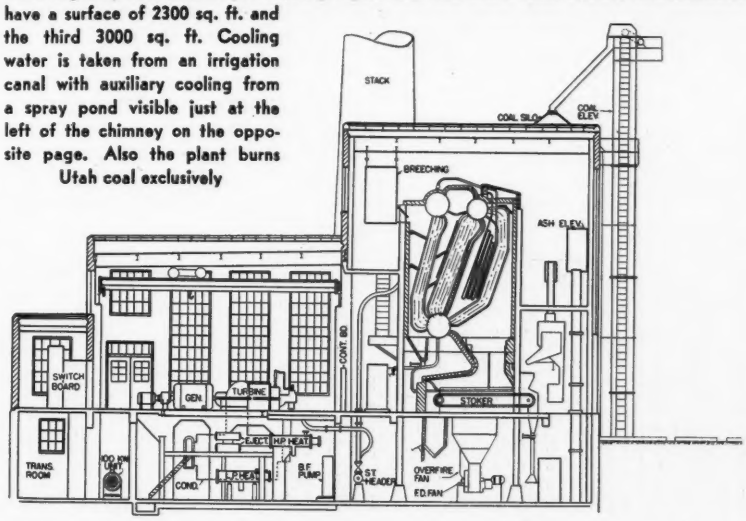
Fig. 1. (Above.) Operating record taken from the monthly log showing the peak load (X indicates the date of occurrence), station power consumption, gross generation and heat rate from the date of initial operation through 1941. Fluctuations in the heat rate are due largely to experiments (usually in 30 carload lots) with various types of Utah coal which varies widely in heat content, ash fusion point, etc. The cost averages about $3.10 per t. delivered. The 2500-kw. unit was put in service Aug. 1, 1941, and the noticeable drop in heat rate over July, 1941, is due to a reduction in standby and banking losses. About 50 t. of coal per month is used for this purpose when a second unit is needed over a 2 to 5 hr. evening peak

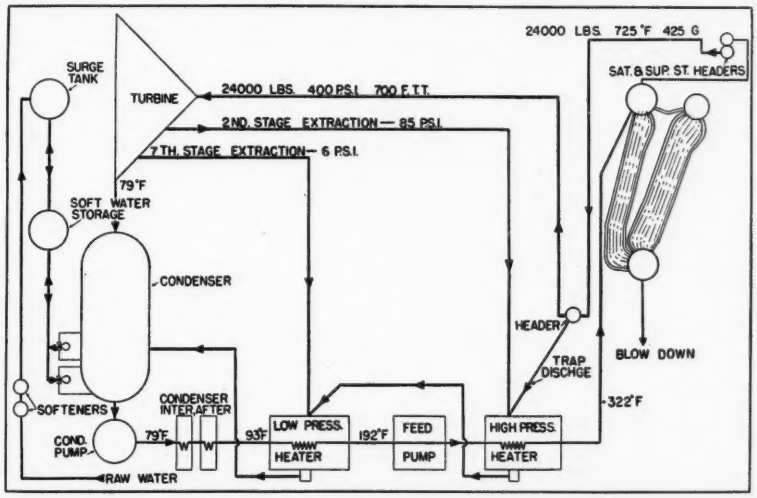
Fig. 2. (Left.) View of the turbine room. The two original 2000-kw. units are at the far side and the new 2500-kw. unit is in the immediate foreground. The office windows with a complete view of the plant can be seen at the extreme left and the switchboard in the far corner. No curtain wall is provided and the turbine end of the generating units face the back of the boilers

1941. On August 1, standby service, contracted for with the nearby Utah Power & Light Co., was discontinued. At no time while the contract was in effect had it been necessary to use the standby service, although it was felt to be a necessary safeguard with peak loads running well over 150 per cent of the capacity of either generating unit operating alone. With the third unit installed, peak loads so far encountered can be handled easily with any two generators in service.

Expansion of the Columbia Steel Co. plant near Provo for war purposes is, however, expected to double the city population. To carry this additional load, a larger plant, adjacent to the present one, is contemplated. This will probably house two 7500-kw. generating units and two 100,000 lb. per hr. boilers.

Fig. 3. Cross section through the original section of the plant with two 25,000 lb. per hr., 450 lb., 725 deg. F. boilers fired by chain grate stokers. The third (new) boiler is similar, but has a capacity of 30,000 lb. per hr., larger gate area and water walls. Two of the condensers have a surface of 2300 sq. ft. and the third 3000 sq. ft. Cooling water is taken from an irrigation canal with auxiliary cooling from a spray pond visible just at the left of the chimney on the opposite page. Also the plant burns Utah coal exclusively





Details of the present plant equipment are given by the list of equipment and the cycle is shown by the flow diagram, Fig. 4. Throttle steam conditions are 400 lb. per sq. in. ga. and 700 deg. F. t.t. and the full load throttle flow for either Unit No. 1 or No. 2 is 24,000 lb. per hr. Turbines are bled at two points, 6 and 85 lb. ga. for feedwater heating. Both heaters are of the closed type, with the hotwell pump discharging through the inter and after condensers, of the air ejector, and the low-pressure heater to the boiler feed pumps. The feed pumps discharge through the high-pressure heater to the boilers, at full load the feedwater is 322 deg. F.

This was one of the first good sized installations of the Aldrich-

Fig. 4. Flow diagram with steam flow and temperatures for 2000 kw., or full load on Units Nos. 1 and 2. As originally installed drains from the high pressure heater cascaded directly to the low pressure heater hotwell. The continuous flash made the low pressure heater float operated drainer work erratically. This was corrected by changing the high pressure heater drain connection to near the top of the shell where the flash mixes directly with the steam extracted from the seventh stage of the turbine. The boiler feed pumps are of the variable stroke reciprocating type

Fig. 5. View of the boiler room with the new boiler in the foreground. Note the water wall headers and circulators on this new unit. Due to low coal cost no heat reclaiming equipment was installed. Through experimentation it has been found that best results are obtained with a screened and mixed coal—all fines through 28 mesh removed, then mixed with screened coal (minus 1 in. and plus 3/16 in.) in the proportions of 80 per cent coarse and 20 per cent fines. This mixture gives no trouble with segregation and gives an even fire in the furnace

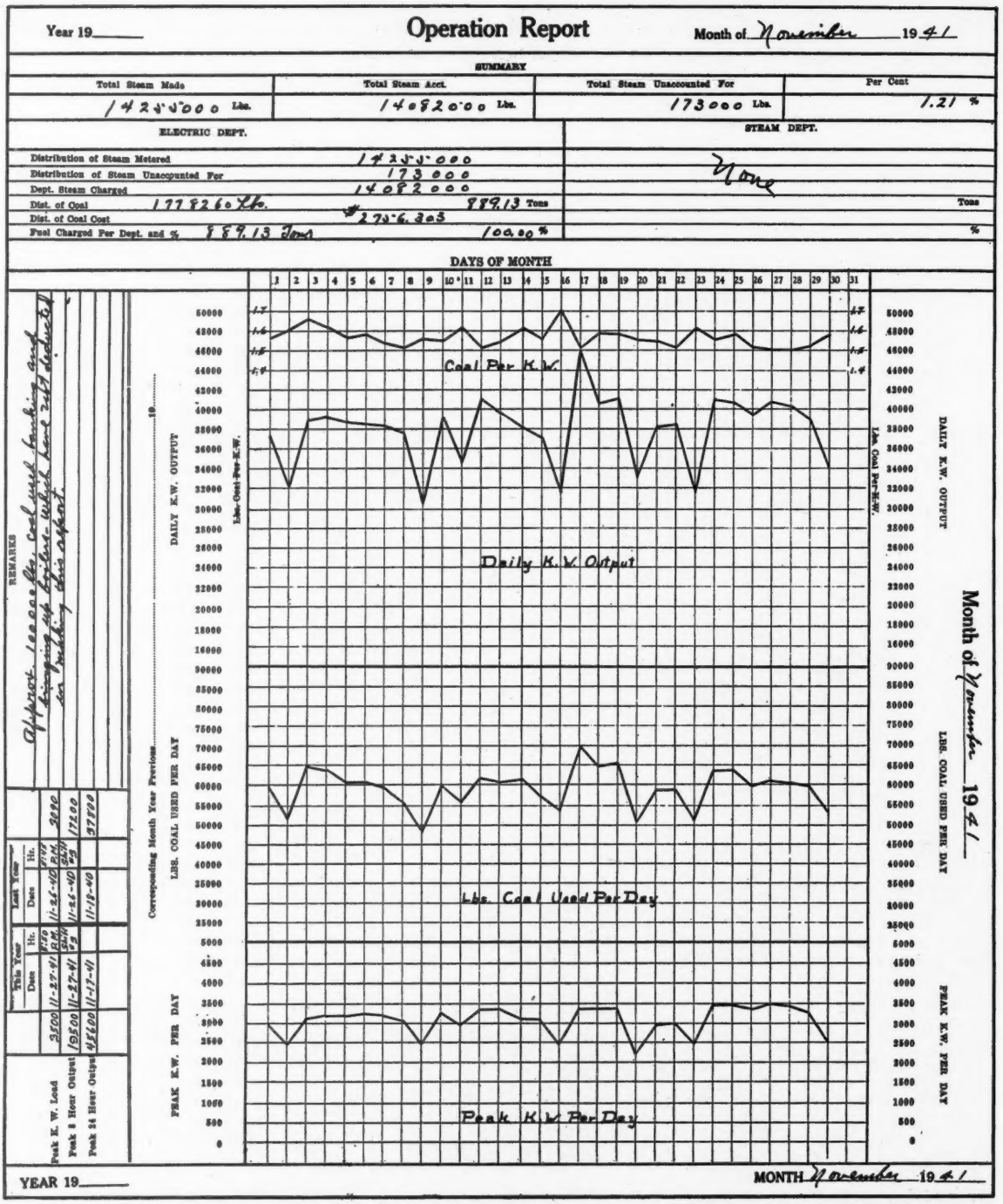


Fig. 6. One side of the station operating report filled in for the month of November, 1941. This report filled in monthly gives a graphic representation of the load and station performance throughout the month

LIST OF EQUIPMENT

Engineer & Contractor—Ulen Contracting Corp.

Turbo-generators—Elliott Co. Three, 3600 r.p.m., 400 lb., 700 deg. F. turbine throttle conditions; generators 2400/4160 v. rated at 0.8 p.f. Two 2000-kw.; one 2500-kw. all with 25-kw., 125 v. direct connected exciters.

Condensers—Elliott Co. Two, 2300 sq. ft., one 3000 sq. ft.

Condensate Pumps—Elliott Co. Two per condenser, 60 g.p.m. each, driven by 5-hp. Elliott motors.

Heaters—Elliott Co. Three low-pressure, heating surface 115 sq. ft. each; three high-pressure, 100 sq. ft. each.

Circulating Pumps—Allis-Chalmers Mfg. Co. Two, 3250 g.p.m. each, 22 ft. head, 860 r.p.m., driven by 25-hp. Elliott motors; one, 3700 g.p.m., 22 ft. head, 860 r.p.m. driven by Elliott 30-hp. motor.

Air Coolers—Griscom-Russell Co. Three.

Oil Coolers—Griscom-Russell Co. Three.

Boilers—Combustion Engineering Co. Three, 450 lb., 725 deg. F., 3 drum bent tube type with Elesco superheaters and fired by C.E. chain grate stokers. Two boilers 25,000 lb. per hr. cap., 4000 sq. ft. heating surface, 84 sq. ft. grate area with American Arch Co. ignition arch; one boiler 30,000 lb. per hr. cap., 4,000 sq. ft. heating surface plus water walls; stoker grate area 98 sq. ft., and Bigelow-Liptak ignition arch.

Boiler Setting—National Power Construction Co.

Feedwater Regulators — Northern Equipment Co., Copes.

Soot Blowers—The Bayer Co.

Gage Column—The Reliance Gauge Column Co.

Safety Valves—The Crosby Steam Gauge & Valve Co.

Blow-off Valves—The Edward Valve & Mfg. Co.

Draft Fans—American Blower Co. Two, 12,000 c.f.m. each, No. 4½ S. I.-H. S. forced draft fans driven by 15-hp. motors; one, 13,800 c.f.m. No. 4 DIDW-AHS forced draft fan driven by a 15-hp. motor; two, 1650 c.f.m. each No. 35, Type E, overfire air fan driven by 5-hp. motors;

Provo City Light Plant Operation for Month of November 1941

ELECTRIC DEPT.

Total K. W. Output	1133800	K. W.	Lbs. Coal per K. W. (Gross Output)		1.705 Lbs.
Total K. W. Used in Plant	11700	K. W.	Lbs. Coal per K. W. (Net Output)		1.640 Lbs.
Net K. W. Output	1084250	K. W.	Cost/cost per K.W. Gross output		$ .002426
% Plant Output Used in Plant	4.13	%	Coal Cost per K. W. (Net Output)		$ .002540
Total Coal Chg. Elect. Dept.	889.13	Tons	Average B. T. U. per K. W.		18208

STEAM HEAT DEPT.

Total Lbs. Steam Charged Steam Heat		Lbs.	Lbs. Coal Used per M. Lbs. Steam		Lbs. Coal
Total Lbs. Steam Metered	None	Lbs.	Coal Cost per M. Lbs. Steam	None	Lbs. Coal
Proportion of Steam Losses Chg. to Steam Heat		Lbs.			
Total Cost Chg. to Steam Heat		Tons			

STEAM GENERATION

Total Steam Made	14255000	Lbs. Steam	Actual Evaporation per lb. Coal	8.09	Lbs. Steam
Total Steam Metered	14082000	Lbs. Steam	Equiv. Evaporation per Lb. Coal	8.10	Lbs. Steam
Total Steam Unmetered and Losses	173000	Lbs. Steam	Net Evaporation per Lb. Coal	7.91	Lbs. Steam

COAL DISTRIBUTION

	% of Coal	Tons of Coal	Cost per Ton	Coal Cost per Dept.	Steam Used per Dept.
Electric Dept.	100.00 %	889.136 Tons	$ 3.10	$ 2756.303	14082000 Lbs.
Steam Heat Dept.	%	Tons	$	$	Lbs.
	%	Tons	$	$	Lbs.
Total	100.00 %	889.13 Tons	$ 3.10	$ 2756.303	14082000 Lbs.

Circuits

1. A Circuit	224100	K. W.
2. B Circuit	236100	K. W.
3. C Circuit	228900	K. W.
4. D Circuit	230500	K. W.
11000 V. Circuit	165100	K. W.
House Circuit	50500	K. W.
Total K. W.	1133800	K. W.

PLANT USE

House Meter No. 1	50500	K. W.
Total K. W.	50500	K. W.

K. W. OUTPUT

Gross K. W. Output	1133800	K. W.
Net K. W. Output	1084250	K. W.
Total Individual Meter Readings	1136250	K. W.

TURBINE OUTPUT

2500 K.V.A. Turbine No. 1	75100	K. W.
2500 K.V.A. Turbine No. 2	32700	K. W.
3000 K.V.A. Turbine No. 3	1025000	K. W.

POWER PURCHASED

Shift No. 1	None	K. W.
Shift No. 2		K. W.
Shift No. 3		K. W.

BOILER FLOW METER LBS. STEAM

No. 1 Boiler	1887000	Lbs. Steam
No. 2 Boiler		Lbs. Steam
No. 3 Boiler	12368000	Lbs. Steam

TURBINE FLOW METERS LBS. STEAM

2500 K.V.A. Turbine No. 1	960000	Lbs. Steam
2500 K.V.A. Turbine No. 2	636000	Lbs. Steam
K.V.A. Turbine No. 3	12486000	Lbs. Steam

OPERATION OF BOILER ROOM

SHIFT	M Lbs. Steam	Lbs. Coal Used	Lbs. of Ashes	Lb. Coal per B.Hp.	Net Evap.	Act. Evap.	Equv. Evap.	Steam Pres.	Steam Temp.	F.W.T. Temp.	Breech Temp.	Boiler Eff. %	CO2	Peak Hr. Demand	Boiler Rating	B. H. P. Output
No. 1	2850	360660	3664	3.79	7.90	7.94	8.09	419	620	256	513	74.9	7.2	23000	570	9530
No. 2	5128	649190	7152	3.79	7.90	7.90	8.05	426	690	288	535	74.6	10.6	36000	1070	17030
No. 3	6276	768410	9476	3.67	8.08	8.17	9.32	426	690	286	584	77.7	11.1	43500	1910	20200
Total	14255	1778260	18312	3.74	7.91	8.04	9.10	424	671	276	544	76.8	9.6	42424	1444	16760

OPERATION OF BOILERS

BOILER	M Lbs. Steam	Lbs. Coal Used	Lbs. of Ashes	Lb. Coal per B. Hp.	Net Evap.	Act. Evap.	Equv. Evap.	Steam Pres.	Steam Temp.	F.W.T. Temp.	Breech Temp.	Boiler Eff. %	CO2	Pk Hr. Demand	Boiler Rating	Hours Oper.	Days Oper.
No. 1	1887	269900	2544	4.23	6.94	7.05	7.84	427	645	284	537	68.4	—	9900	780	163	26
No. 2																	
No. 3	12368	1510360	13768	3.66	8.07	8.20	9.24	423	667	278	534	77.2	9.9	23200	1360	664.30	
Total	14255	1778260	18312	3.74	7.91	8.04	9.10	424	671	276	544	76.8	9.6	—	—	—	—

OPERATION OF ELECTRICAL DEPT.

SHIFT	K. W. Output	Lbs. Steam Used	Steam Loss	Lbs. Steam Per K.W.	Lbs. Coal Per K.W.	Coal Used Elect. Dept.	B.HP. Gen. Elect. Dept.	Coal Pr. % HP.	Peak Load	Power Factor	Load Factor
No. 1	211400	2850000	46000	13.2	1.70	360660	9350	3.96	23000	82.5	38.3
No. 2	419900	5064000	64000	12.1	1.55	649190	16880	3.84	37000	90.5	56.4
No. 3	1044500	12130000	63000	12.3	1.52	768410	20700	3.71	43500	91.0	60.0
Total	1133800	14082000	173000	12.4	1.56	1778260	46940	3.79	43500	88.0	44.6

OPERATION OF TURBINES

UNIT	K. W. Output	Lbs. Steam Used	Steam Per K. W.	Total Coal Used	Lbs. Coal Per K.W.	Peak Load	Days Operated	Hours Operated	Peak Steam Demand
2500 K.W. No. 1 / 2500 K.W.	75100	960000	12.8	122330	1.62	2000	14	81	24000
No. 2	32700	636000	19.8	58350	2.39	14500	12	102	18000
No. 3	1025000	12486000	12.2	1597580	1.53	2900	30	684	36500
Total	1133800	14082000	12.4	1778260	1.56	—	—	—	—

OPERATION OF STEAM HEATING DEPT.

SHIFT	Total Lbs. Steam	Lbs. Coal Charged	Lbs. Coal Per M. Lbs. Steam	B.HP. Steam Used	Actual Evap.	Net Evap.	Out Door Temp.	REMARKS:
No. 1		None						
No. 2								
No. 3								
Total								

COAL REPORT

	BUNKER Tons	BUNKER Rate	BUNKER Amount	CARS Tons	CARS Rate	CARS Amount	STORAGE Tons	STORAGE Rate	STORAGE Amount	TOTAL Tons	TOTAL Rate	TOTAL Amount
On Hand	165.72	3.10	513.732	50.85	3.10	157.635	450.00	3.10	1395.00	266.57	3.10	826.367
Purchased				1262.85		3915.135				1262.85		3915.135
Total	165.72		513.732	1313.80		4072.770	450.00		1395.00	1529.42		4741.502
Delivered	596.75		2779.924	1313.80		4072.780				1272.855		
Total	762.47		3293.657	—		—	467.00		1447.855	1529.42		4741.502
Used →	589.13	3.10	2756.303							589.13		2756.303
Total	173.34		537.354	—		—	467.00		1447.855	940.29		1985.209
Shrink and Credits							32.00 →	2.85	6.976	2.24		6.976
Balance	173.34	3.10	537.354	—		—	464.80	3.10	1440.879	638.14		1978.234

COAL ANALYSIS

Kind of Coal	Blue Blaze
Moisture	11.28 %
Volatile Matter	48.28 %
Fixed Carbon	40.98 %
Sulphur	.44 %
B.T.U. Per Lb. (As Received)	11630
B.T.U. Per Lb. (On Dry Basis)	13128
Ash	10.2 %
Fusion Point of Ash	—

Operation Report For The Year 19....

Report Made Out By... Dale H. Price.....

Operation Report For The Month Of Nov. 1941

Approved By Ray W. Brown Eng.

Fig. 7. Reverse side of the Operation Report giving a detailed tabulation of the electric, steam, and coal distribution and the operation of each major piece of equipment in the plant

one, 1570 c.f.m. No. 7 Type PB, overfire air fan driven by a 7½-hp. motor. All motors are Westinghouse, 1750 r.p.m.

Combustion Control—Hagan Corp.—Complete for all boilers.

Flow Meters—Cochrane Corp.—Six.

CO_2 Recorders—The Hays Corp.—Three.

Chimney—The Rust Engineering Co. One, 729 ft. above foundation, 7 ft. 6 in. I.D. at top.

Coal & Ash Equipment—Fairfield Eng. Co. Track hopper, bucket elevator, 200 t. coal silo, weigh larry and bucket type ash elevator.

Boiler Feed Pumps—The Aldrich Pump Co. Three Aldrich-Groff, 2½ by 0 to 4 in. stroke, vertical triplex, capacity at 250 r.p.m. and 95 per cent volumetric eff., 60 g.p.m. each, driven by 25-hp., 1750 r.p.m. Westinghouse motors.

Aux. B.F. Pumps—The Dayton-Dowd Co. One, size 2½ in., 4 stg. centrifugal driven by an Elliott Type 2AY, 3500 r.p.m. steam turbine.

Water Softener—Elgin Softener Corp. Zeolite, dual unit, cap. 637 gal. per hr.

Fabricated Piping—Grinnell Co.

Valves—The Chapman Valve Mfg. Co. and the Crane Co. on high-pressure steam and water lines.

Strainers—The Fisher Governor Co.

Water Meters—Neptune Meter Co. Trident.

Traps—Yarnall-Waring Co. Impulse type.

Switchboard—Westinghouse Elec. & Mfg. Co. 9 panels, bus structure, instruments and remote controlled oil circuit breakers with an interrupting capacity of 50,000 kv-a. at 15,000 v.

Station Power Trans.—Allis-Chalmers Mfg. Co., three 37½ kv-a., 2400/240-480 v.

Stat. Lgt. Trans.—Allis-Chalmers Mfg. Co. One 10 kv-a.; General Electric Co., one 25 kv-a., both 440/120-240 v.

Air Compressors—Ingersoll-Rand Co. Two, 2 stg., Model 25, self contained compressors driven by 5-hp. Westinghouse motors.

Oil Refiner—Honan-Crane Co. Two, 50 gal. per hr. cap., thermostatically controlled.

Crane—The Whiting Corp. One, 20 t., hand powered.

Building—Groneman Contracting Co.

Ventilating & Plumbing—P. L. Larsen.

Electrical Wiring—William Frisby.

Glazing—Utah Valley Paint & Glass Co.

Roofing—E. J. Mower.

Table I. Operating report of the Department of Utilities, City of Provo, Utah, for the month of November, 1941, the year 1940 (8 mo.) and the year 1941

		Nov. 1941	8 mo. 1940	Year 1941
	GENERAL			
1.	Plant thermal efficiency, generated, %	18.70	18.40	18.10
2.	Plant thermal efficiency, net output, %	17.95	17.60	17.25
3.	Pounds of coal per kw-hr. generated	1.565	1.52	1.57
4.	Pounds of coal per kw-hr. net output	1.64	1.59	1.64
5.	B.t.u. per kw-hr. generated	18,208	18,540	18,900
6.	Peak steam demand, lb. per hr.	42,500	39,000	44,500
7.	Peak load, kw.	3,500	3,200	3,560
8.	Plant load factor, %	45.00	42.40	40.70
9.	Plant average load, kw-hr.	1,577	1,410	1,445
10.	Plant water rate, lb. per kw-hr.	12.40	11.80	12.23
	COAL			
11.	Total coal consumed steaming, lb.	1,678,260	11,915,595	18,930,580
12.	Total coal used banking and bringing up boilers, lb.	100,000	240,000	960,000
13.	Total coal consumed, lb.	1,778,260	12,155,595	19,890,580
14.	Total coal used in No. 1 boiler, lb.	267,900	7,941,550	4,445,250
15.	Total coal used in No. 2 boiler, lb.	None	4,214,045*	6,444,410
16.	Total coal used in No. 3 boiler, lb.	1,510,380	None	9,000,920
17.	Average moisture in coal (as fired), %	10.37	8.22	9.29
18.	Average ash in coal (as fired), %	5.20	6.25	6.54
19.	Average B.t.u. in coal (as fired), per lb.	11,635	12,200	12,039
20.	Average volatile in coal (as fired), %	45.36	44.80	44.20
21.	Average fixed carbon in coal (as fired), %	38.06	41.30	40.00
22.	Kind of coal used	Spring Canyon & Blue Blaze	Utah Coal	Utah Fuel
	WATER			
23.	Total water evaporated No. 1 boiler, lb.	1,887,000	65,505,000	35,103,000
24.	Total water evaporated No. 2 boiler	None	31,861,000	50,529,000
25.	Total water evaporated No. 3 boiler, lb.	12,368,000	None	73,988,000
26.	Total water evaporated lb.	14,255,000	97,365,000	154,962,000
27.	Total hours steaming No. 1 boiler	163.0	4,250	2,443
28.	Total hours steaming No. 2 boiler	None	2,220	3,134
29.	Total hours steaming No. 3 boiler	664.0	None	4,041
30.	Total hours out of service No. 1 boiler	None	1,414	6,317
31.	Total hours out of service No. 2 boiler	744.0	3,444	5,626
32.	Total hours out of service No. 3 boiler	80.0	None	4,719
33.	Drum pressure, lb. ga.	424	431	430
34.	Steam temperature, deg. F.	671	690	675
35.	Number of boiler blow downs	150	1,016	1,825
36.	Number of soot blowers operations	30	254	365
37.	Feedwater temperature inlet to boilers, deg. F.	276	286	278
38.	Flue gas temperature at boiler outlet, deg. F.	544	529	539
39.	CO_2 at boiler outlet, %	9.6	11.3	10.00
	OPERATING EFFICIENCIES			
40.	Actual evaporation per pound of coal	8.04	7.94	8.02
41.	Actual evaporation per pound of coal steaming	8.50	8.17	8.43
42.	Equivalent evaporation	9.10	9.27	9.48
43.	Operating efficiencies coal steaming, %	80.1	73.6	76.25
44.	Operating efficiencies total coal, %	75.8	71.5	73.20
	TURBO-GENERATORS			
45.	Hours in service No. 1 generator	81	4,371	3,539
46.	Hours in service No. 2 generator	52	2,067	2,606
47.	Hours in service No. 3 generator	684	None	3,502
48.	Average steam pressure, lb. ga.	400	400	400
49.	Average steam temperature, deg. F.	654	690	675
50.	Total kw-hr. generated No. 1 turbo-generator	75,100	5,526,300	4,497,500
51.	Total kw-hr. generated No. 2 turbo-generator	35,700	2,456,200	3,032,800
52.	Total kw-hr. generated No. 3 turbo-generator	1,025,000	None	5,134,800
53.	Total kw-hr. used for auxiliary power	51,550	315,970	549,250
54.	Total kw-hr. net output	1,084,250	7,666,530	12,115,850
55.	Total kw-hr. gross output	1,135,800	7,982,500	12,665,100
56.	Total percent kw-hr. used for auxiliary power	4.50	3.91	4.34
57.	Total steam consumption No. 1 turbo-generator, lb.	960,000	64,646,000	53,877,000
58.	Total steam consumption No. 2 turbo-generator, lb.	636,000	29,361,000	38,175,000
59.	Total steam consumption No. 3 turbo-generator, lb.	12,486,000	None	62,913,000
60.	Total steam consumption, lb.	14,790,000	94,007,000	154,965,000

Groff variable stroke, reciprocating boiler feed pumps. Three were installed in the original section and the low power consumption at all loads is the major contributing factor to the low station power consumption, which runs consistently below 4.5 per cent of the gross generation. Reliability has been high and maintenance low. During the past 21 mo. operation they have been repacked once, in September, 1941. The centrifugal pump installed with Unit No. 3 is a turbine driven emergency pump and is started occasionally only to keep it in good operating condition.

The three variable stroke pumps discharge to a common header. The stroke (capacity) is controlled by the Hagan combustion control system with limit switches on the Copes feedwater regulators to safeguard against low water. When the boilers are operating at different loads the feed pump capacity is governed by the heaviest loaded boiler and the other (or others) is controlled manually from the control panel.

Due to the low cost of Utah coal, about $3.10 per ton delivered, no heat recovery equipment of any kind was included. The third boiler does, however, have water walls and this, except for the larger grate area, is practically the only difference from the first two boilers. We have, however, done considerable experimenting with different coals, usually in 30 carload lots, to determine the best for our equipment.

In general, Utah coals are all satisfactory, but vary widely in heat content, ash fusing temperature, etc., and this to a large extent accounts for the variation in heat rate from month to month. We have found that, from the standpoint of segregation and an even fuel bed, best results are obtained from a

(Continued on page 83)

Table II. Summary of operating and maintenance costs for: November, 1941, for the year 1940 (8 mo.), and for 1941. Including depreciation, the cost per kilowatt hour on the switchboard was 7.45, 7.45 and 7.42 mills per kw. hr. gross respectively for the three periods

	November 1941 1 mo.	Year 1940 8 mo.	Year 1941 12 mo.
Supervision	$ 250.00	$ 2,026.71	$ 3,000.00
Boiler labor	692.12	4,802.45	8,244.81
Prime mover and generator labor	723.86	4,478.00	7,673.02
Miscellaneous station labor	157.67	535.87	1,683.36
Fuel	2,764.30	18,753.26	30,905.94
Station supplies	82.33	1,078.03	1,272.13
Miscellaneous station expense	95.13	271.36	1,266.34
Structures and improvements	150.63	20.60	443.59
Maintenance:			
Coal and Ash Equipment	14.84	146.43	207.27
Boiler Apparatus	133.47	360.84	985.03
Furnaces and Boilers	391.70	476.28	1,289.27
Steam Piping and Accessories	49.94	305.68	581.49
Prime Movers and Generators	97.26	193.29	1,975.01
Miscellaneous Equipment	18.28	355.90	745.99
Insurance	161.53	1,575.43	2,118.30
Depreciation	2,684.16	16,338.53	25,628.76
Standby Service	None	7,998.01	6,000.00
Total Production Costs	$8,467.22	$59,716.67	$94,020.31

Table III. Construction costs, including engineering, of the complete plant with two 2000 and one 2500-kw. units. The cost per kilowatt of capacity comes to $111.27

Land, track, etc.	$ 7,984.21
Building	82,904.44
Boilers, combustion control, etc.	171,396.84
Boiler feed pumps	16,311.85
Coal and ash handling equipment	19,585.65
Chimney	10,975.60
Water softening equipment	1,058.97
Turbines, Condensers, Found., etc.	305,306.17
Piping, insulation, etc.	41,999.36
Water supply structures	38,938.92
Switch board	11,850.86
Emergency generator	6,440.27
Crane	3,225.10
Air compressors and miscellaneous	5,260.44
	$723,238.68

Mercury-Vapor System Attains Reliability

By H. N. Hackett
Construction Engineering Dept.
General Electric Co.

EARLY experiments with the mercury-vapor-steam cycle on a 100-hp. boiler and later on a 1500-kw. unit, operating at 10 p.s.i. gage, and 730 deg. F. vapor temperature, indicated that mercury was practically inactive to iron or steel.

As time went on and larger boilers were built burning greater quantities of fuel, it was discovered that the heat-absorbing ability of a tube filled with mercury was not only uncertain, but unpredictable to such a degree that pronounced overheating and actual damage to the boiler tubes occurred. Furthermore, mercury did cause disintegration of the steel to such a degree, by dissolving slowly great quantities of iron from the inside walls of the tubes and redepositing it in the cooler regions, that the tubes became plugged at their upper ends. Overheating occurred, due to restriction of mercury circulation.

The full importance of these difficulties was not appreciated until after the two 20,000-kw. units—one installed in the Schenectady Works of the General Electric Co., and the other in the Kearny Generating Station of the Public Service Electric and Gas Co. of Newark, N. J.—were placed in service in 1932 and 1933, respectively. However, the first positive results of mercury attack on the tube steel were evident after 9 mo. of operation of the 10,000-kw. mercury unit in the South Meadow Station of The Hartford Electric Light Co. in 1930. Because of incorrect diagnosis, nothing of a fundamental nature was done to correct the trouble.

From 1912 up to the present time the mercury-steam, binary-vapor cycle of generating electric power has been undergoing constant investigation and development. The first practical application attempted was at Dutch Point Station in Hartford in 1922. This was definitely experimental but gave such encouraging results that other installations followed. South Meadow Station was installed in 1928; one at Schenectady for General Electric Co. and another at Kearny Station for the Public Service Electric and Gas Co. of New Jersey in 1932; at the River Works in Lynn, Mass., G. E. installed a forced circulation mercury boiler in 1937, and another small unit the same year at Pittsfield, Mass.; the latest installations have boilers of entirely new designs, one being in the Marcus Hook Refinery of the Sun Oil Co. in 1939 and the other replaced, in 1940, the earlier boiler installed in the Kearny Station. This last installation is now reported as having carried an average hourly load of 205 per cent of the national average for steam-generating units in 1940.

While every installation showed improvements over previously built boilers, scientists and engineers were unable to predict operating results with sufficient accuracy for commercial purposes until the last installations were put into service. High points in the story of the investigations carried on with mercury to discover and remedy the causes of failures were told in a paper presented at the recent A.S.M.E. Annual Meeting and the article presented here has been abstracted from the basic material presented.—Editor.

Mercury Attack on Tube Steel

The rapid dissolving of the iron from the lower tube surfaces with the subsequent redepositing of the metals, as either iron or iron oxide at the top, and the unexpected overheating of the tubes were both problems for which no immediate answers were available.

It was believed that, if the dissolving of the iron could be stopped, the operation of a mercury boiler would be satisfactory, as relatively long intervals between pickling operations would not be objectionable. To accomplish this desirable result, three general lines of attack were followed.

Steel specifications were altered and various alloys were developed in an effort to find a material that would reduce, or, if possible, entirely eliminate the loss of metal by dissolving. Some success was attained, as certain alloys showed definite improvement.

An all-liquid boiler using alloy tubes, in which the mercury-liquid temperature continuously increased throughout the heating circuit, was built and thoroughly tested in the belief that the dissolved metal would not be released in the tube circuit, but in a large receiver or flash chamber where flashing of the heated liquid occurred. These hopes were only partially realized, as some dissolving of the tube material, as well as appreciable deposits of oxidized metal, did occur after a few months of operation.

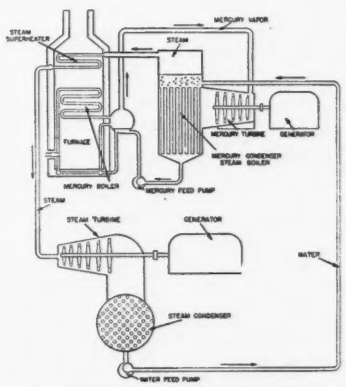
Overheating of the mercury-filled tubes was not cured entirely by either of these two procedures, although considerable improvement did occur with the all-liquid boiler.

Research on Effect of Mercury on Steel

Ultimate and complete success was realized, however, as the result of an extremely active research program in which the metallurgical and chemical properties of mercury, combined with other metals, were thoroughly studied by the scientists and chemists of the General Electric Laboratory.

The steel was found to be perfectly wetted with the dilute mercury-sodium-titanium amalgam to such a degree that intimate and positive contact occurred between the steel and the mercury. The spheroidal properties of the mercury were entirely gone, and the liquid spread over the tube surface to form a tenacious layer almost impossible to wipe away.

Sodium was believed to be the wetting agent, causing a breakdown and removal of oxides on the surface of the steel and in the mercury, thereby allowing actual intimate contact of the mercury and the steel. The sodium was also thought to reverse the meniscus of the mercury, thereby causing it to



Mercury-Vapor-Steam-Electric Generating System

spread uniformly over the tube surface to produce the effect of wetting.

Treatment of Boiler Mercury at Kearny

For certain reasons, Kearny was chosen for the first application of what is now known as "treatment of boiler mercury." During the night of March 4, 1934, sufficient metallic sodium in the form of a 25 per cent sodium-mercury amalgam was added to the boiler mercury to bring the sodium concentration to 100 p.p.m. by weight of mercury. No titanium was added as yet. The immediate results were astounding, as the boiler, at the time the sodium-mercury amalgam was added, could only carry 20 per cent of full rating without overheating the boiler tubes. Immediately after the injection of the amalgam, the fire was increased to produce one-half capacity. The following day, the load was increased to full rated output of the boiler and was subsequently operated continuously for 3 mo. During this period, efforts to add titanium to the mercury were ineffectual. Various appliers were used, but to no avail, as the titanium refused to dissolve in the boiler mercury. However, the boiler appeared to operate satisfactorily with no overheating of the furnace tubes.

These results were very gratifying, but actual success was only partial, as stoppage occurred in certain furnace tubes of the mercury boiler. This time, however, the effect was different, as the plugging was not at the top of the tube but at the bottom, caused by a ball of hard material which, when analyzed by the chemists, was found to be a mechanical mixture of mercury and sodium ferrite.

The elimination of sodium ferrite, $Na_2OFe_2O_3$, the end point of a chemical reaction between sodium, iron oxide, and oxygen, was believed to be a difficult problem. Further tests were conducted which proved conclusively that oxygen was the principal offender.

Improvements Made in System

The turbine shaft rotating at high speed in shells in which high vacuum is maintained must be perfectly sealed. Many feet of welded and bolted joints must be made absolutely tight, as well as the stems of leaking valves. None of these things were required in steam plants of like size.

New and effective shaft seals were built, using the centrifugal force of a revolving cup of liquid mercury to form the seal; designs were altered; the best technique of welding was employed for making welded joints tight; flanges and valve stems were sealed by special means. Air infiltration was reduced from 500 cu. ft. per hr. to less than 1 cu. ft. per hr.

Further laboratory and field tests disclosed that magnesium and titanium had all the desirable wetting features of sodium and titanium and none of the undesirable ones, so magnesium replaced sodium in the boiler mercury. It was found that magnesium did not form the hard dangerous balls when reaction between the metallic magnesium and iron oxide or free oxygen took place in the boiler mercury. The final products of the reaction were, instead, a very fine, dry, harmless powder consisting of free iron and magnesium oxide, easily removed from the boiler mercury.

Improvements Bring Success

All the known improvements were made on the Schenectady unit in 1937, with immediate and unqualified success. No difficulties or unexpected results from the mercury or its ingredients developed, and the equipment operated at satisfactory output 93 per cent of the time for the next 18 mo., when further alterations were made to the plant to increase its capacity.

An entirely new boiler, embodying all the developments so painstakingly discovered, was built and placed in operation in the Marcus Hook Refinery by The Babcock & Wilcox Co. for the Sun Oil Co. in early 1939, for the purpose of producing lubricating oils. Its complete success as a new venture, designed and planned to incorporate all the known facts, made it appear that sufficient knowledge was at last available to expect predicted results.

The Kearny unit was rebuilt with complete success and its record of operation has rarely, if ever, been equaled by steam units of similar size. The new mercury boiler followed conventional steam-boiler designs and employed all the facts so carefully learned at Schenectady, Marcus Hook, and Pittsfield. Simple through-flow mercury circuits were employed, using fog-type convection surface to the limit of existing experience with the result that, of the 24,407 sq. ft. of mercury heating surface, 17,400 sq. ft., or 71 per cent, was of the fog type, which is empty of liquid mercury at starting. The only liquid-filled tubes are those below the center line of the mercury drum.

Even though a mercury boiler of like dimensions and operating temperatures (150 p.s.i. 985 deg. F.) had never before been built, using such quantities of alloy metals, assembled throughout by perfect welding, the unit went into service in May, 1940, and has operated almost continuously since at 20,000 to 21,000 kw. either coal or oil-fired, generating power at 9200 B.t.u. per kw-hr., the lowest B.t.u. rate per kw-hr. in history, with only two short outages due to equipment failures. The normal rated output of the unit is 21,000-kw. from the mercury-turbine generator and approximately 30,000-kw. from the by-product 365 p.s.i. ga. steam produced.

During more than 15 mo. of operation it has carried an average hourly load of 205 per cent of the national average for steam-generating units for 1940. The scientists, chemists, and engineers can now produce predicted results. The successes at Schenectady, Marcus Hook, and Kearny can be duplicated over and over again, with ever-improving efficiencies. Mercury at Kearny now produces 1 net kw-hr. for 0.5 lb. of fuel oil. If a new plant were built of similar capacity, the fuel burned to generate the same amount of power would be still less. If, in the future, mercury were used at 500 lb. pressure and 1500 deg. F. temperature, the power could be produced at a fuel consumption of only 0.41 lb. of oil per kw-hr.

Proper Wetting Is Essential

A tube surface properly wetted with treated mercury is coated with a tenacious film which because of high surface tension can be superheated considerably above its normal saturation temperature before becoming destroyed due to heat application, as long as the film is continuously supplied with other treated mercury as fast as loss is sustained by evaporation from the surface of the heated film. Such thermal action makes possible the use of large-diameter tubes, fed by relatively low-density mixtures, or a fog of mercury vapor and mercury droplets of the order of 5 parts of liquid to 1 part of vapor or less, by weight, with complete safety at high rates of heat input. As long as reasonable mixture velocities are maintained, the tubes may be operated in any position.

Part XIII
Conclusion

Well, here it is—technical interest, excitement, suspense, romance and success all ingeniously combined in one thrilling final chapter. Love in an icebox or a practical approach to the study of insulation. From all of which one can deduce that if your love affair runs cold take your girl into an icebox. They lived happily ever after

REFRIGERATING ENGINEER

By GEORGE HOLMAN

WHILE you have been working at the Wholesome, unnoticed changes are taking place. There are constant changes in the storage, changes in load, changes in both suction and discharge pressures, changes in the sound of each machine. The pressure gages fascinate you. The discharge pressure is often high early in the morning when the day is cool, then falling as the day gets warmer. This p u z z l e s you for awhile, until you determine by psychrometer that the wet bulb reading sometimes drops after the day warms up and the dew disappears from the grass and the neighborhood roofs. You also note that the cooling tower cools the water much better on a windy day than on a still one.

The variations in the temperature differential of the condensing water keep you stumped the longest. Sometimes when you first take over in the morning the differential is up to 11 deg., dwindling to 9 by the time you go off shift at three in the afternoon. And with all compressors running. If a compressor shut off, you could understand it; there would be less heat delivered to the water.

Less heat to the water. Now you have it. Early in the morning right after Andy gets through harvesting ice, the pressure in the tank coils is 6 to 8 lb. higher than later in the day, due to the brine temperature being higher. At 25 suction by the gage, 20 per cent more gas will be delivered by the compressor to the condenser than at a gage pressure of 17 lb. And if the amount of water flowing through the condenser remains constant, as is the case with your constant speed recirculating pump, such water must absorb the extra heat delivered by the compressor. Consequently the temperature of the water leaving the condenser will be higher.

By and by, there comes a time when the sharp freezing coils and also the low temperature cooler coils must be defrosted. Two of the coils have so much frost on them that air can no longer circulate between them. On placing loads in the rooms, the temperatures become increasingly hard to hold down. Nothing to do but take that frost off. You ask Frosty about the proper technique.

When Defrosting, Guard Against Liquid Hammer

Frosty says, "Where you've got two or more low-pressure systems discharging into the same high-pressure system, defrosting is easy. All you've got to do is to pump out the coil or coils you are going to defrost, then shut down and open the bypass and pump out valves on your compressor. Instead of going to the condenser, the hot gas from the other machine or machines will blow through the bypass and pump-out valves into the coils you have pumped out. Be careful when you first begin to open those valves, though. If you open them too fast, the first gas going into the frost-coated coils may be cooled and condensed before it gets half-way through the length of the coil. A slug of liquid could be formed. With very low pressure ahead of it, and with very high pressure behind it, that little slug of liquid might strike the return bends of the coil some awful wallops. That place has the coils welded and tested under air and ammonia gas pressure of 150 lb. gage. While they may stand that much steady pressure, a hammering blow from a slug of liquid striking one of those bends may burst the pipe wide open. Liquid hammer works in a refrigerating system just like it does in water or steam lines. The thing to do is to play safe. Don't try to defrost one coil at a time. Get as many as you can handle. Then when you first open the bypass and pump-out valves, the gas will have so many ways to go that the pressure rise and condensation in any one coil will be gradual. Even though those low-pressure systems have been tested under 150 lb. gage, I wouldn't let the pressure of the defrosting gas go higher than 100. That way, you'll have a factor of safety of one and a half."

I'm getting this refrigerating business down pat," you inform Frosty, after the frost is off the coils and the systems are back in operation. "But there is one thing I'm still weak on. That's insulation. Sometime I want you to give me a few pointers on it, how effective cork insulation is and so on. In practice, I mean."

Insulation. You learn something about the effectiveness of insulation without appealing to Frosty. You learn by experience just how well insulation performs the place assigned it in the refrigerating game.

Comes the Girl Friend

It so happens as you are about to go off duty one day that your

weakness crops up. "Good-afternoon, Mr. Workman!" she smiles from the window. "Are you busy?"

"Never too busy for a word with you, Honey! Come in."

"Hunnh-unh," determinedly.

"Now, now! Just this once. You haven't stepped into the place since I started to work here. And you've passed here a hundred times. Come on in."

"Hunnh-unh," not so determinedly.

"Just this once. I want to show you how I've cleaned up this plant. Not a grease spot nor a smell of ammonia in it. As soon as the weather gets cooler, I'm going to paint up. I'm even going to paint the outsides of the ice cans. With a bituminous paint, though. Now, come on in and look things over."

"Hunnh-unh," reluctantly.

"Please!"

"Oh, well. All right, then."

You lift June from the sill, but collect a window toll before setting her on the floor. Proudly you show June the plant, speaking seriously of the things you did to straighten up the place and laughing when you tell her of the time you looked for the funnel to put oil into the crankcase.

You get back as far as the machine room doorway Allen blusters in. "Well, break it up, you two!" he grins. "I don't like to intrude. But this is my place of business. It's 3 o'clock, so I'm on duty."

You blush, and fail to go with Allen as he checks over the compressors and then goes into the tank room. "While you're here, you might as well see everything there is to see," you tell June. "Let's look around in the storage."

It is near closing time when you enter the storage. Butch is busy transferring some cuts of meat from the showcases to the lower temperature of a main locker. His two helpers have already gone.

You turn on the lights and enter the hall. You go first into the chill room. There the tables and cutting blocks are all in order. A dozen freshly killed hogs hang on the racks.

Trapped in the Cooler

From the chill room you go into and out of several coolers. In one are crates of oranges and baskets of apples; in another, cured meats; in yet another, beef hung up for seasoning. At the sharp freezer away down at the end of the hall you jerk the door latch twice before the door will open. That door has been sticking rather often lately. You have been intending to fix it, but just haven't gotten to it yet. You open the door and June steps into the freezer. You follow her. More out of habit than for any other reason, you pull the door shut behind you. You hear the latch click, but think no more about it—for a minute.

"Brrrr!" June purrs. "I don't want much of this. The thermometer shows five below zero."

"Pretty cool spot," you concede. "Well, let's get out of here."

Let's. You push on the plunger which is supposed to open the latch from the inside. The plunger goes through the door and right up to the knob. There it sticks. You push on it. It goes no farther. You cannot pry it back. You shove on the door. It seems as solid as the wall. You get back and rush the door. Under the impact of your shoulder, there is a grunt, but whether from the door or from yourself you cannot be sure. You rush the door a dozen times, but without success. You are looking about for a bar or some tool with which to pry the door open when with a suddenness that fairly dazes you, the lights go out. At once you know the truth of the situation. Butch is closing the market and going home.

You let out a series of yells at varying decibel levels before you realize that no one can hear you through those thick walls, made still thicker and almost soundproof by 6 in. of cork lining the freezer. You turn and face the darkness where June is. "I should have told Butch that we were coming back here," you tell your companion. "He probably didn't see us come in."

"Must we stay here all night?" June wonders, and you can hear a scared note in her voice. "We'll freeze!"

You try the door again, then commence a systematic search for something with which to pry it open. You find nothing, and after trying the door a dozen more times, sit down on a stack of pasteboard boxes. June stumbles over to you and sits down on your knee. "Can't you do something to get us out of here, Darling?" she asks.

Now when a girl like June asks something like that while sitting on your lap and calls you Darling into the bargain—well, it makes you feel like you could just kick that door off the hinges and go on out. But in practice the kick doesn't work. After a terrific kick at the door you limp and fumble your way back to the boxes.

You think of your cigarette lighter, and of the pasteboard boxes in which are fish, lettuce and what-not. A fire would be pretty comfortable right now. And it would be easy to build one. But a fire would soon use up all the oxygen in the room, and you and June may then suffocate. You take out your lighter anyhow, and light it. June warms her fingers at the tiny flame, then smiles bravely behind the ghostly pallor the feeble light gives her face.

You extinguish the lighter and try to think. Overhead you can hear the ammonia singing as it evaporates in the coils. Suddenly you have a bright idea. Why not shut that ammonia off? Although you can't warm the freezer up any, you can at least keep it from getting colder. You jump up, feel your way to the two wall coils, and close the stop valves ahead of the thermoexpansion valves. But in order to reach the ceiling coils, you are compelled to stack up several of the boxes before you can reach the valves.

The valves closed, you climb back down. The exertion has warmed you somewhat, but not so with June. She is shivering. "Let's dance, Honey," you try to take her mind off the discomfort of the situation. "You hum and I'll whistle."

You move some of the boxes, and in the cold and darkness dance for an hour. At the end of that time you are tired, and colder

You dance for an hour

than when you started. You light your lighter and look at the thermometer and June's wrist watch. It is ten minutes after six. And the temperature is now two below zero. Overhead the ammonia has ceased to sing in the coils.

"Must we stay here until morning?" June asks again. She shivers, and moves closer to you.

The Cold Hath Compensations

"Not till morning, Honey," you assure her. "Allen will be around and let us out before then."

You tear the pasteboard covers off a number of boxes and pile them on the floor. You settle down on them, and draw June down beside you. "How will Allen know that we are in here?" June whimpers.

"Don't worry," you try to comfort her. "He'll know."

Huddled among the scraps of pasteboard, with your shirt and both arms around your companion, you whisper slowly, "June!"

"Yes, Abel."

"Will you marry me?"

"Yes, Abel. If we don't freeze to death."

Eleven o'clock comes, and still no Allen. You are so cold that you are beginning to get sleepy. Then, as suddenly as the lights went off, they blindingly come on again. In a quivering voice you shout, "Hello!"

Someone is fumbling with the latch on the door. Then in the light from both the freezer and the hallway you see both Andy Piper and Allen Knowles before you. Andy just stands and stares, while Allen rushes to help you and June get up stiffly.

And So They Lived Happily Ever After

The weather is warm enough to warm up just anywhere out-of-doors, but you and June choose the machine room with Allen and Andy. Over the coffee from Allen's thermos bottle and a lunch which Andy goes out to get, you and June laugh about your little adventure. "Abel kept telling me that you would come around and find us," June tells Allen. "But how could you find out that we were there?" And how could he know that you would know?"

"He cut the ammonia liquid off on me," he laughs. "He knew that the pressure would fall, and by that I would know that something was wrong in the freezer. I would have been around sooner, but I didn't notice the gage. First I had trouble with the pump. Then I had to answer the telephone twice. When I did notice the gage, I thought that the scale trap ahead of the solenoid stop-valve was stopped up. I cleaned it. And when that didn't help matters, I knew that something was wrong in the freezer itself. What it was I couldn't imagine."

"Didn't Daddy or anybody call about me?" June wonders.

"Yes. But when I told him that I last saw you with Abel, he just said 'Well, guess I've got a new son-in-law. I'll bet they've eloped!'"

At the Colfax home Frosty meets you at the door. "Allen Knowles just called to tell me he had you two in cold storage," he grins. "I wasn't worried, because I figured that when you did show up that I would have another one of my accounts with the Devil settled by the acquisition of a new son-in-law. Now, I'll have to change my mind and be satisfied with just a good refrigerating engineer."

"Oh, we don't intend to disappoint you there, Daddy," June smiles, first at her father, then at you. "Do we, Abel darling?"

The End

UTAH MUNICIPAL PLANT MAINTAINS RECORD

(Continued from Page 78)

sized coal, which we call an 80-20 mixture. In practice, all of the minus 28 mesh is removed, leaving a mixture; about 20 per cent through $\frac{3}{16}$ in.; and 80 per cent through 1 in. but retained on $\frac{3}{16}$ in. screens.

In addition to the main building there is a 42 by 30-ft. warehouse connected to the power house basement by a tunnel with an overhead crane. The warehouse basement is used as a machine shop, which, well equipped with a lathe, drill press, power hack saw, grinder and welder, enables us to do practically all our own work. The top floor of this building is equipped as a laboratory, primarily for boiler water tests.

Costs

Station costs broken down in Table III, including engineering, totaled $723,238.68, which on the rated capacity of 6500-kw. comes to $111.27 per kw. of installed capacity. Operating costs for the month of November, 1941, for the 9 mo. operation during 1940 and for the entire year of 1941 are shown by Table II. Including insurance and depreciation, the cost per kilowatt hour delivered to the switchboard (gross generation) came to 7.45, 7.45 and 7.42 mills per kw-hr. respectively for the three periods.

Station performance, output, station requirements and load conditions are shown by Fig. 1 plotted as monthly averages from the initial operation through 1941. The peak load curves indicate the highest 15 min. peak of the month and the date of occurrence is indicated on the curve by a cross. The monthly operating report form is shown by Figs. 6 and 7 filled in for the month of November, 1941.

Personnel and Management

Mayor Mark Anderson, anxious to choose an experienced and capable superintendent, finally after careful consideration selected R. C. "Rocky" Adams, then chief engineer of the Fremont (Neb.) municipal plant. Mr. Adams in turn selected the writer[1] as chief engineer. We both started work the first of January, 1940, followed construction closely, set up a complete record system and, in conjunction with the Utility Board previously set up by Mr. Anderson, chose from 350 applicants an operating crew of 10 men on a merit basis. With the exception of one man who accepted a civil service position in Ogden, Utah, the original personnel is still on the job, constituting, we believe, after experience and special training, one of the best trained crews in the country, and a perfect safety record—not a single lost time accident since starting operation.

On March 1, 1941, Mr. Adams resigned to become vice-president of the Bixby Co. of Des Moines, Ia. He was succeeded as superintendent by Ray Coffey, superintendent of the Hastings, Neb., plant, who in turn resigned September 1, 1941, to take a position with an engineering company in Salt Lake City. Ray Ringerhagen, formerly cost accountant of the Fremont (Neb.) Dept. of Utilities, is now superintendent, and he, with T. J. Oldroyd, office manager, recently set up the office accounts to conform with the Federal Power Commission Uniform System of Accounts.

[1]Editor's Note: Mr. Brown at the time was chief engineer of the Schuyler (Neb.) municipal plant. Preceding that he was for 14 yr. with the City Water & Light Dept., Hastings, Neb. Starting as a coal handler, he had advanced to assistant chief engineer when he left Hastings for Schuyler, Oct., 1938.

War News From the Industrial Front

Diesel Engine Producers Limit Prices

INFORMAL arrangements whereby Diesel engine prices will not be increased above the levels of October 1 will be continued for the present, OPA Administrator Henderson announced late in December.

On December 6, the administrator requested Diesel engine manufacturers to adhere to October 1 prices and not to change their methods of determining prices for specially designed equipment. A meeting at which makers of 85 per cent to 90 per cent of all Diesel engines were represented was held December 18 at the OPA offices.

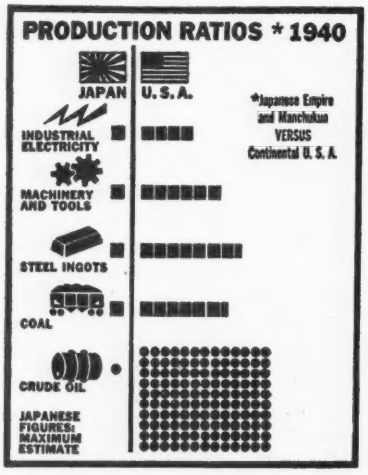
Attending producers expressed the opinion that the voluntary method of keeping prices stabilized would be effective for the time being. However, to implement the voluntary price control program, Diesel engine manufacturers were asked to file with OPA affirmations that they have complied with his request of December 6.

Power Pooling Revoked

ON JANUARY 3 the power limitation order (L-16) issued October 30, 1941, to meet a power shortage in the Southeast was revoked effective January 5. J. A. Krug, chief of the OPM power branch, sent a letter to the utilities asking them to continue the pooling arrangement on a voluntary basis to the extent necessary to assure the complete filling of reservoirs. This includes the operation of steam plants at full capacity.

Natural Gas Shortage Serious in Nine States

AN URGENT appeal was issued by Government agencies January 8 asking all consumers of natural gas in nine States, mostly in the Middle West, to cut their consumption as much as possible during the current cold wave in order to make gas available for war production plants. When residential consumers increased their consumptions as the temperature went down rapidly, the shortage became serious in Illinois, Indiana, Ohio, Pennsylvania, West Virginia, Western New York, Michigan, Kansas and Missouri.



No. 2 Rolls at Grand Coulee

GRAND COULEE'S second 108,000-kw. generator, assembled at seven leagues' pace to meet power demands of expanding industries building war materials, has had its test run early last month. A 2 wk. period was required for examining the unit, control and distribution equipment under varying electrical loads, drying out its windings, and testing its bearings.

Production of power for commercial use was scheduled for the middle of January. Unit No. 1 in service since October 4 was scheduled for a layoff to permit engineers to make a final check of its operation and to replace temporary control mechanism with permanent equipment.

No. 3 generator is scheduled for service in March and the 150,000-hp. turbine is already in place. The Bureau of Reclamation is attempting to accelerate delivery of six more generators and plans call for installing three machines in 1943 and three more in 1944. Early this year construction of the dam's second powerhouse will be started and the Bureau expects Consolidated Builders, Inc., the contractor, to finish the job in 18 mo.

Paint for Blackouts Too Hot!

USE OF BLACK or dark blue paint to cover windows is not recommended for general use by the Consumer Div. of OPA. Windows blacked out in this manner cannot be opened during blackout unless curtains have also been provided.

One large New York department store, with hundreds of windows to cover quickly during an emergency, plans to use black paint, but paint men warn that the black paint will absorb the heat of the sun's rays and expand much more than the glass to which it adheres, bringing up the danger of breakage. Besides, unexpectedly large purchases of black paint at this time would unbalance the supply of critical defense materials.

Common Sense in Hiring Aliens

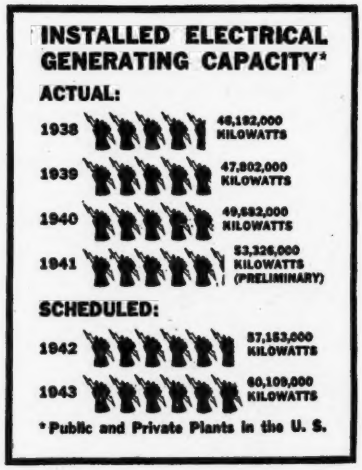
IN ANSWER to questions recently raised as to restrictions on the employment of aliens in all war industries, William S. Knudsen and Sidney Hillman January 10 made the following joint statement:

"There is no legal barrier to the employment of aliens in any factories having war contracts. It is only in those manufacturing plants which produce secret items for the Army or Navy that the permission of the armed services must be secured by the employer before aliens are hired.

"Aims of democracy and the needs for efficiency alike demand that ability and loyalty shall not go to waste. In doubtful cases, the appropriate Government agencies are prepared to take proper measures. In all-out war production, we must utilize every human resource with sanity, with common sense, and the conviction that no one shall be denied opportunity to participate in the war effort because of race, creed, color, or national origin."

Power Pooling and Rationing

ACCORDING to Government agencies, power deficiencies in 1942 and 1943 seem certain in several important strategic defense areas, including the Southeast,



the Southwest, the Pacific Coast, and part of the Middle West. Public and private power agencies serving those areas have not been asleep at the switch for they anticipated increased power demands and ordered new power equipment accordingly. The defense program, however, did not remain static and the things we need most, like aluminum, magnesium and chemicals are the very things whose production eats up power at a tremendous rate.

Unfortunately, it hasn't been possible for power facilities to keep up with the step-up in production. While a new powder plant or a new aluminum plant can be built in 6 mo. it takes 2 yr. to build a new steam plant and as long or longer to build a power dam.

Steam turbines with a total generating capacity of 3,000,000 kw. were ordered in 1940 and 4,500,000 kw. in 1941. Hydro or waterpower generators ordered in 1940 amounted to 500,000 kw. in 1940 and double that amount in 1941. Of the steam turbines ordered in the 2 yr., probably not more than 2,000,000 kw. have been completed, leaving a backlog of more than 5,000,000 kw. still to be completed.

The same industry has also had the job of building marine turbines for our two-ocean navy and our expanding merchant marine and naval vessels are floating power plants. For example, a big

(Continued on Page 110)

The PRACTICAL ENGINEER *and* ELECTRICIAN

RICHARD H. MORRIS, EDITOR

If You Don't Like It —It's Your Own Fault

There is no use denying that, for a number of months, I have been waiting in pleasant anticipation my turn as editor of the P. E. & E. It is the most exacting, trying, involved and at the same time the most satisfying assignment on the editorial staff. There is no "virtue is its own reward" or "quietly burying mistakes" here because hundreds of letters call the score immediately in unmistakable terms.

This being the operating man's section, each letter receives the same weight and attention as its neighbor, although they range from Firemen's pencil notes on wrapping paper to Brass Hats' carefully stenographered letters on engraved stationery. Compliments, kicks, suggestions, articles and answers to questions are included. The volume in itself is pleasing, but the real source of satisfaction lies in the degree of personal interest taken by so many. In reading them over one can sense the implied "There are several thousand of us running the P. E. & E. so we need someone to look after the correspondence and sort things out, but Mr. Editor be careful what you do with our magazine."

To Andy Kramer must go the credit for building up that personal interest and I can but bask in the reflected glory and hope to carry it along for a year. It is, of course, the feeling that all editors strive for. Not all the suggestions can be used for out of hundreds the editor can only hope to reach some compromise agreeable to the largest number.

The danger of course lies in a possible rule by a minority. For instance, if 50 write in and say they do not like the new Patent page out it goes even though 500, who overlooked expressing an opinion (so the editor could hear it) feel that it's O.K., or feel that although they do not like that particular form, that the idea has possibilities worth developing.

Another new feature is the Engineer's Primer intended to show in a series of articles the practical application of the relatively few fundamental principles upon which the whole structure of power generation and application is based.

You may even notice a slight change in the Q. & A. section intended to make it easier for a new subscriber to pick up the thread of the discussion, locate past answers and get an idea of what the original question was. The Q. & A. Dept. has been criticized for having too many, sometimes conflicting answers.

This we believe is inevitable. Beyond a few fundamental theoretical principles engineering is the result of practical experience. In few practical questions, which we try to deal with, is a clear cut, definite answer possible. Experts all up and down the line will disagree and can usually give a definite answer after making many assumptions, usually not justified by the original question.

Editing a magazine is of necessity a compromise between the conflicting needs and desires of many groups. Unless you write in to say what you like or do not like, or participate actively in the discussion or submit your ideas and experiences for publication, you have only yourself to blame if it's not what you like.

Richard H. Morris.

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A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE

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TURBINE SEALING GLANDS

On all turbines some type of seal is necessary to prevent steam leakage along the shaft from the high-pressure end, and, the leakage of air inward on the vacuum end. Stuffing boxes are impractical and the three principal types of gland seals used alone or in combination are: the labyrinth; the carbon ring; and the water seal. They may be used alone or in combination depending upon the type of turbine. With water seals both the water pressure and quality are important. Some types also have steam seals and others steam leakoff connections

BY J. D. SCHMIDT
Westinghouse Elec. & Mfg. Co.

BECAUSE the rotating part must operate without physical contact, sealing a space between a rotating and a stationary part has always been a problem, especially when the rotative speed is high and both parts are made of metal. While the best of the sealing devices now in use on steam turbines leave something to be desired, there are several types of seals which may be used under various sets of operating conditions with good practical success.

Three principal types are used: the plain labyrinth seal; the carbon ring gland; and the water seal gland. The first of these types does not purport to prevent leakage, but to reduce it to a relatively negligible quantity. This is true of the second type also, although its characteristics and range of application are somewhat different. The third type does eliminate leakage as such, although a certain minimum quantity of steam is lost by condensation in the presence of the water used for sealing.

In the case of the first type, the labyrinth seal, a certain minimum leakage area exists, determined by the minimum safe operating clearance between the rotating and stationary parts, and the circumference of the shaft at the gland. The amount of steam which will leak through this leakage area in a unit of time is obviously dependent upon the pressure drop across the seal. With only a single labyrinth element the leakage would of course be large, because the pressure drop would be the total difference between the internal and external pressures. If, however, a second sealing element having the same minimum leakage area is introduced, then (disregarding the effect of the expansion of the steam through the first element) the pressure drop across each of the two elements is but half as great as it was before, and the leakage is therefore greatly reduced. Similarly, by multiplying the number of elements, the leakage through the final element to atmosphere can be reduced to relatively a very small value.

The general principle of the carbon ring gland, shown by Fig. 2, is the same as described above, but because of the very low coefficient of friction of carbon on steel, and by providing means to permit the carbon rings to adjust themselves within the gland casing, it is possible to operate such glands with much smaller radial clearance than is practicable with a labyrinth type gland. Consequently the carbon ring gland is particularly suited to applications on small diameter shafts and with limited axial space.

In the water seal gland the low coefficient of friction of water is made

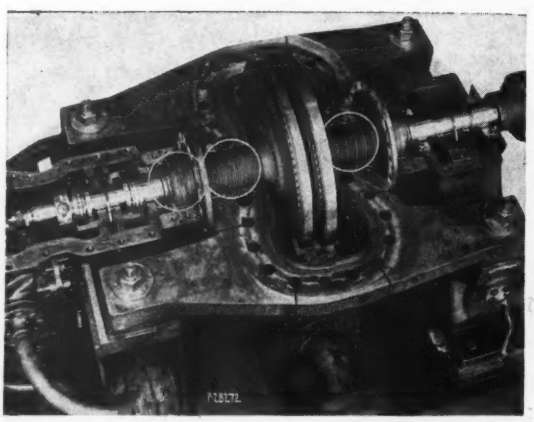


Fig. 1. Labyrinth and water glands as used in combination on a mechanical drive turbine are indicated by circles. The labyrinth glands are shown in detail by Fig. 3, the water glands by Fig. 5

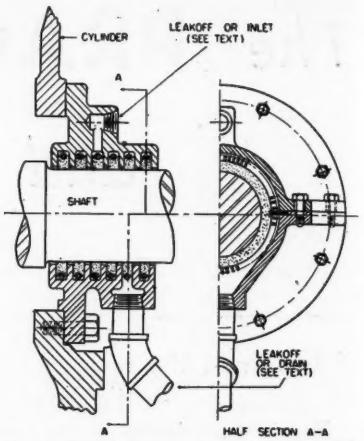


Fig. 2. Carbon ring glands can be made with close clearances and are particularly applicable to small high-speed shafts. Here again leakoff connections can be used to prevent the loss of steam. Where operating conditions require it, a sealing steam connection can also be used. In general, whenever the pressure inside the turbine cylinder is above atmospheric, the openings at the top of the gland cases are used as leakoffs, and whenever the cylinder pressure is below atmospheric they are used as steam inlets

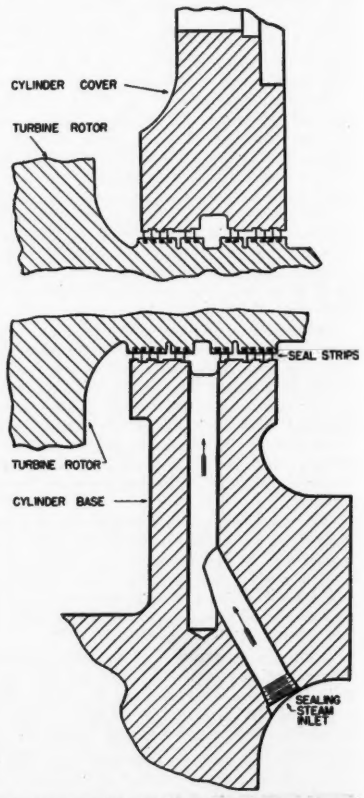


Fig. 3. Details of a labyrinth gland seal used in conjunction with a water seal against high internal pressure. For sealing against a vacuum, sealing steam is supplied to the center of the gland and leaks out both ways, thus effectively preventing the inflow of air. For sealing against high steam pressure, the gland may be provided with one or more leakoffs to some lower pressure point so that most of the steam leakage can be reclaimed

use of to permit the interposition of an actual physical barrier to prevent the escape of steam from the inside of the turbine to the atmosphere. This is accomplished by providing within a housing a rudimentary type of centrifugal pump runner arranged to be supplied with water at its outer periphery as shown by Fig. 5. The characteristics of this runner are so chosen that if supplied with water at the center, as in a pump, it is capable of pumping against a head slightly greater than that required to seal against the internal pressure.

When this pump runner is supplied with water at its periphery only, the water tends to force its way toward the center of the impeller, but this tendency is of course opposed by the pumping action of the impeller. The result is that the peripheral space between the runner and the housing is completely filled with water and the runner itself submerged to an extent dependent upon the pressure of the sealing water supply. Consequently this annulus of water around the runner serves as a solid barrier against escape of steam outward, or, air inward to the cylinder. Obviously with this type of gland, if the temperature of the steam within the cylinder is very high, means must be provided to permit circulation of water through the gland in order to prevent **boiling.**

The gland is designed to be used on turbines operating under a variety of conditions. The leakoff openings shown are provided so that as much leakoff pipe area can be utilized as may be required by the particular conditions or application. Thus any or all of these leakoff openings may be employed in specific instances.

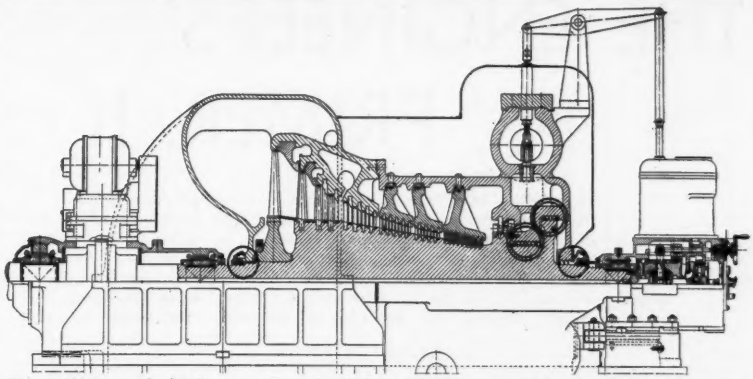


Fig. 4. Water seal glands as used on the high and low-pressure ends of a high-pressure condensing turbine are indicated by circles. Details of the glands are shown by Fig. 5. The double circle shows the dummy rings added to counterbalance the end thrust on the turbine blades. They are also built with sealing strips and act similar to a labyrinth seal in reducing leakage. Note the steam leakoff just preceding the water gland. Steam bled off here is saved by piping it to a lower pressure, usually one of the extraction feed heaters. Only pure water should be used in the glands; it is usually supplied from a constant level overhead tank

The small leakoff marked "D" is used for condensing operation when the cylinder space is under vacuum, in which case all the other leakoff connections would be plugged and the connection D should be connected to the main exhaust chamber of the turbine or to the condenser. The gland leakoff steam is usually piped to an appropriate feedwater heater.

Sealing steam in water seal glands is used simply to insure that water from the water seal will not flow along the shaft into the turbine cylinder, resulting in local cooling and distortion of the shaft. The steam pressure required may be as much as 30 lb. upon starting up, but will normally be not more than about 10 lb. when operating at full load.

In other types of glands the required steam pressure is dependent upon the operating conditions and the number of labyrinths, or carbon rings, in the gland. The water pressure employed in water seal glands is usually about 5 lb. per sq. in. greater than the highest pressure against which the gland has to seal. Leakoff steam from the glands is usually piped to one or another of the feedwater heaters, depending upon the operating conditions.

A discussion of the field of application of the several types of glands might well run into many pages, but, in the briefest terms, it may be said that in general constant speed turbines of the larger capacities are equipped with water seal glands or combinations of water seal and labyrinth glands. On small units, where the peripheral speed of the shaft will permit, carbon ring glands are commonly used. If ample space is available, however, straight labyrinth seals may be used.

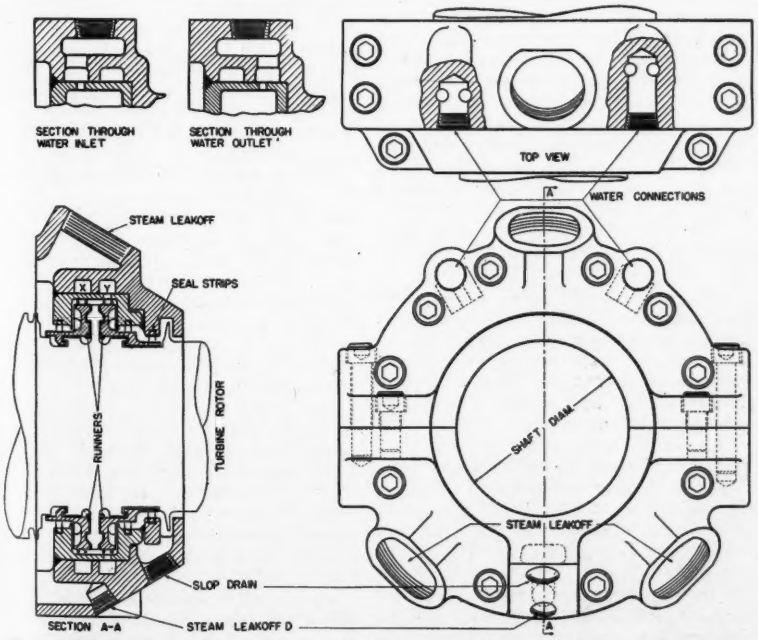


Fig. 5. Details of a modern water sealed gland showing the runner, leakoff, drains, water supply connections and sealing strip which in themselves act as small seals to reduce leakage by throttling. The water gland is in effect a small centrifugal pump which operates to fill the clearance space with a solid ring of water. Due to friction losses and steam condensed, the water heats up and a constant flow must be maintained to keep the water from boiling

---

Tungsten fuses at 5400 deg. F., but if it is powdered and subjected to heavy pressure it will weld together in a solid mass at relatively low temperatures. It can then be drawn into filaments for lamp bulbs or other uses.

* * *

Where close tolerances on embedded structural steel are required, with massive concrete substructures, the best method to employ is that of the so-called "grouting system." This method requires setting the steel after the main body of concrete has been poured. Recesses are made by using box forms with reinforcing bars or ties for the structural steel left exposed. After all forms have been stripped, the structural steel can then be placed, lined up by means of piano wires and other devices, and cement grout placed around it.

THE ENGINEERS' PRIMER. II

A few words about the heat balance, its purpose, use and limitations with a bit about the main characters who will develop the Primer around the relatively few basic principles from which power generation has grown. In Part I Mac and Andy discussed, on the way to work, the real function of the power plant and disagreed a bit over the merits of a fellow engineer, Jim Perry. Andy drives around to pick Mac up after work and the discussion continues, rather one-sidedly, because Mac has been thinking and is well wound up

By Richard H. Morris

SORRY to keep you waiting here at the gate, Andy, but I was sorting out some old papers that carried me back to another day and another war, much the same as this one in its bustle and confusion. Yet, it's different, for it brought a bunch of us here in town together and this one has already begun to scatter us to the four corners of the earth.

Do you know Jack Carmody? No? Well, few people do—perhaps no one does. He's friendly in a reserved sort of way. I've never known him to be discourteous to anyone, yet he's tough as a longshoreman and has a code of ethics all his own.

Everyone calls him Jack behind his back—but to his face it's always Mr. Carmody or Captain. We went to the same grammar school, but he was several years older and I never really knew him. By the time I started high school he had gone away to college. Graduated a couple of years before the war started.

Gossip says the old man took it pretty hard when Jack refused to take an interest in the business which had been in the family for three or four generations. He traveled a bit and when the war started went to one of the first officer's training camps. By the time I got in, he was a captain and I landed in his company.

It was then and still is his company, although only a half dozen of us that have done the gum shoe work

Andy's boss—the Merry Miller—though a bit old fashioned never passed up a laugh or an honest dollar

know the pains he went to to see that every man he could locate had a job through two depressions. It was this sense of responsibility that brought him and Jim Perry together, although that was before my time with the company.

Jim was about 17, his mother was dead and he used to come up to camp to visit his father occasionally. His father died in the hospital that first winter and Jack promised to look after the boy. To some this might have been taken as the adopted son of a rich man, but neither Jim nor Jack took it that way. Both have the same feeling that no man deserves more than a chance to prove what he can do and the opportunity to work out his own salvation.

Jim has had a chance to do it his own way. Jack hasn't, for fate has stepped in at every turn. Shortly after the Armistice Jack's father died and as sole owner he had to pick up the business whether or no. The old man had been conservative and frugal, the company was in good shape financially with a fine organization and weathered the post war depression in fine shape.

His mother died about that time, and I think that Jack, freed of any responsibility to anyone else, deliberately set about ridding himself of the company, that apparently he has resented all his life—not that it didn't give him all he needed but because it kept him from following his own inclinations.

Anyway he made two or three small mergers, then plunged in earnest, acquired several financially embarrassed companies on a shoestring. He played to lose and won at every turn. Finally in desperation he resigned himself to whipping his unwanted octopus into shape as the new Commodities, Inc. This play on words touched his odd sense of humor and was in effect a sarcastic jibe at the "new economic era" school of expansive big business which was just getting under way in the early '20's.

In the meantime Jim Perry had gone to work in the power plant which happened to be the only opening at the time. As more promising openings came up the father, and later Jack, tried to get him to change but found no interest. The power plant was the job he wanted and finally Jack gave up in disgust, feeling that perhaps his earlier confidence in the boy's ambition and ability had been misplaced.

As occasion demanded Jim would be fireman's helper, oiler or repair man, all the time building a solid practical foundation under old Sandy McNair for his future success. Sandy was a bit of a mystery around town for a good many years. About 1910 after a slug of water had wrecked the engine he appeared at the gate one morning looking for a job. He fixed up the engine and stayed on as chief.

At that he was both a success and a failure. The plant always ran like clockwork and repair costs were negligible, but he never thought of changes or improvements and the men wouldn't

Captain Jack Carmody—Tycoon in spite of himself — head of Commodities, Inc., and Jim Perry's employer

stay. Said he made them polish brass and scrub floors till it drove them nuts like he was. As a matter of fact, he wasn't quite right.

From newspaper clippings found among his papers when he died in 1921, it turned out he was an old marine engineer, chief on the old *Queen of Scots* when he was rammed and sank in a fog off Newfoundland one night in 1908.

Scotty apparently had served his time, built the engines and followed them to sea to be sure they were well cared for. He was badly injured in the collision, but was splashing around waist deep in water sloshing the bright work of his engines with grease when the second engineer went below and dragged him up, literally by the scuff of his neck, no mean job in itself with a man of Scotty's size.

Jim, alone in a strange town, liking machinery and careless of long hours, managed to hit it off fine with Sandy. That old engineer's cap that he always keeps in the engine room, and the old engine in a glass case, is his way of paying tribute to a man that gave him a start by teaching him the things that can't be learned out of a book.

Anyway Jim inherited Scotty's job and I met him a couple of years later in a night school class. What was I doing there? Well, perhaps my wife wouldn't altogether approve of one of the reasons, but there were several. After the war I went back to school,

graduated, bummed around a while and finally came home and started in here as a wiper.

I was long on book learning and short on practice, Jim was the other way around, so we made a pretty good team. Now that we both have a little of each we still find it handy to work out things together if they are a little out of the regular run of mine.

Three or four years with Scotty had taught Jim about everything that could be done with his hands or tools, but the long hard hours with Scotty's blank mind hasn't exercised his brain much.

He told me that after Scotty died he continued to put in his 12 hr. a day, seven days a week, fully believing that the only purpose of Sunday was to give him a chance to repair the plant. Because he lacked Scotty's years of experience, even the necessity for keeping coal on hand and the engine in repair made him plan ahead, although his world then did not extend beyond his plant.

It was somewhat of a shock to him when Carmody casually handed him a sample copy of a magazine one day and he realized that there were other plants. It was something that had not occurred to him before because he had started in as a kid and had been too busy to think about it. He wasn't a dumbbell though and he read that magazine pretty thoroughly. One thing that struck him was that a feedwater heater would save approximately one per cent of the fuel for every 11 deg. F. rise in feedwater temperature.

Probably there had been a feedwater heater in the plant once, but not within Scotty's time or he would have fixed it up. What returns at that time simply came back to a large cast iron storage or sump tank from which the feedpump took its suction. Well water which is pretty soft here was used for makeup and the temperature probably ran somewhere from 80 to 100 deg.

Times were hard, business was not very good and even 10 per cent savings in coal was something to think about twice. Rather self consciously he sent for catalogs and studied them carefully at night. By the time he bolstered up courage enough to suggest a heater to Carmody, he knew the story word for word and made himself clear enough so that the Captain thought it worth while looking into.

Perhaps Jim sold him the idea, perhaps a salesman did and it's even possible that he thought the few dollars a worth while gamble to drag Jim up from the black gang. Anyway he passed the whole thing over with a "God help you if it doesn't work."

Finally the heater was ordered and installed. It was with some pride that Jim gave it a final inspection and put his tools away late one Sunday night to go home and get a few winks before it was time to come back and start up Monday morning.

Monday morning was an eventful one, with the heater alternately flooding and running dry, the feed pump hammering when the water got too hot and the engine running herself while the whole plant looked on and offered advice. Finally, however, the float was adjusted and peace restored to the plant. "Fortunately," the fireman remarked, "the load is light this morning."

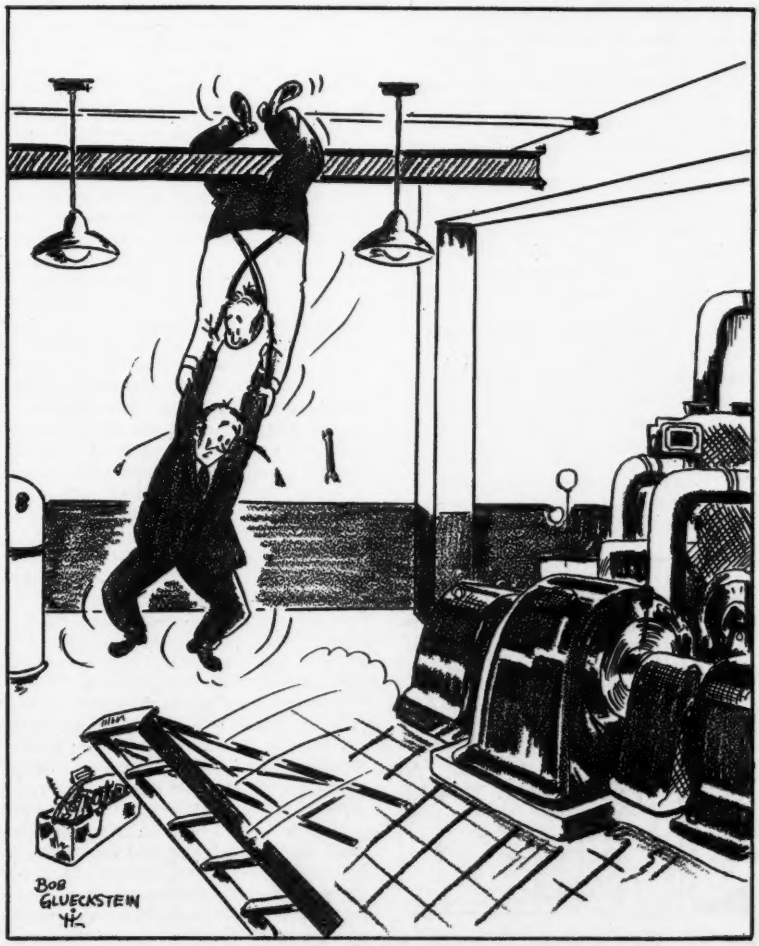
The light load continued all afternoon and the next day and Jim was becoming impatient for a heavy load so that the effect of the heater would show up. It was not until he discovered, later in the week, that the mill output since the preceding Wednesday had been almost 10 per cent above normal for that period that the part being played by the heater dawned upon him.

The Captain had little to say, but was obviously pleased, not only because of the savings but because it appeared that perhaps Jim would amount to something after all. Jim had little difficulty in explaining it all but it was still just a little bit hazy in his mind as to just how the heater did manage to save the coal. That's why he landed up in night school—remember he was not illiterate—he'd been to school until he was 17, knew some mathematics and had even had a course in physics. But he wanted something a little closer to his plant, something to give him the why and wherefore of what he was doing.

It's funny what will confuse people and cause them trouble. Our greatest difficulty in those days, outside of the regular class work, was to reconcile the loose way more experienced engineers spoke of that indefinite thing "the heat balance". Everybody seemed to use the words for a different thing and yet everyone seemed to know what everybody else meant.

To Jim it was all Greek, to me it seemed that a heat balance must be a strict accounting of the heat change in a cycle, as for instance Hern's analysis of engine performance, a grand and glorious conglomeration of mental contortion but not very practical for everyday use.

To some it was a simple diagram with no figures, to others a complicated diagram full of figures, a tabulation of a few lines or one covering several pages; others spoke of days, weeks or months or carefully specified loads; others drew from it elaborate conclusions as to efficiencies; while a few broad minded individuals dispensed with all facts, figures and diagrams and claimed the heat balance as good



"Woops! Lucky I caught you, Boss!—You know, perhaps this is as good a time as any to ask you for a raise!

or bad depending upon how much steam they wasted to atmosphere.

All in all it was very confoosin' but not at all amoosin', that is, until we invited the instructor out one night to explain it all to us over a stein of beer. The beer was good and so was the instructor, an oldish man who must have been born to be an actor. Here are his words just as I copied them down then about 20 yr. ago, with a bit of retouching up after I got home.

"A heat balance, my boy, is 'everything to all men' and no power plant is complete without one. It is simple, yet elusive and intangible, and is to the power plant what 'God Bless Our Happy Home' was to the household of 40 yr. ago. It is the character of the plant, something built into it when the equipment is assembled just as the character of the man is developed during his youth.

"Kilowatts and horsepowers continue to roll out even though the neatly tabulated sheet you may call a heat balance does not exist even as the household continues without the motto as a physical manifestation of its occupants' sentiments.

"Nevertheless, this physical manifestation gives one a sense of well being, something definite at which to point and show the world that accomplishments are the results of preconceived thoughts and directed effort rather than chance. To a certain extent the heat balance, just as a boy's character, can be planned and developed always, of course, within definite limits of financial means, material to work with and environment. Environment in a human being compares roughly to the operation of a power plant. The design of the plant can be carefully planned, yet one bad machine or one careless operator can render all planning worthless.

"As nearly as can be visualized or defined, the plant heat balance is a statement, tabulation or diagram showing where the heat, put into the furnace in the form of fuel, went to just as a bank balance is a statement showing where the money deposited went.

"You go to the bank in a hurry and deposit a certain amount of money, say $500. During the course of the month you take out $50 for spending money and write a few checks, yet at the end of the month you find a lot of blank checks left but the bank says 'No funds.' You get a statement, showing on one side the amount deposited and on the other side a list of items including among other things the $50 you actually took out and used, the checks you wrote, collection fees, discounts, service charges and perhaps several worthless checks, the total of these miscellaneous items equaling the amount deposited.

Jim Perry—Engineer through his own efforts —a graduate of the school of Hard Knocks and still a student

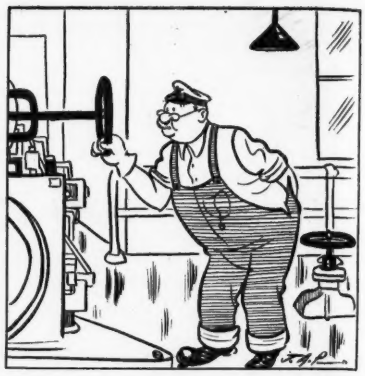
"In a power plant during the course of an hour, say, you put in 500 lb. of 10,000 B.t.u. per lb. coal, totaling 5,000,000 B.t.u. From the generator you take out 146 kw. hr. or about 500,000 B.t.u. The remaining 4,500,000 B.t.u. has been lost in the flue gases, ash, exhaust and many other losses. Your heat balance would then show on one side the 5,000,000 B.t.u. put in and on the other side the several items or heat losses which took place between the furnace and switchboard.

"If your interest lies only in the output, if you need so much power regardless of the amount of heat you put into the furnace, the heat balance is of no value to you, but the losses are still there and can be determined if necessary. If you have enough money so you are interested only in taking a certain amount of money out of the bank each month, week or day regardless of the amount you put in, the bank statement is of no value to you even though it is there and available for the asking.

"Chances are, however, if you put in $500 and only take out $50, you will want to know what became of the other $450. Perhaps you are taking in too many worthless checks, perhaps the bank's charges for collection, service and discounts are too high. You know there are certain service charges that must be paid for the convenience of the bank's facilities and there are a certain number of worthless checks that come around in the general course of business. Seeing these charges and deductions, really losses, tabulated, however, you are in a position to judge whether they are excessive and if so consider changes to remedy the condition.

"An engineer knows that there are certain inherent losses involved in the conversion of fuel to power. Ash in the fuel, flue gas losses, condenser losses, radiation, electrical losses and friction are the worthless checks and bad debts of business. They can be reduced by good management but not entirely eliminated. But knowing what each loss is, enables the engineer to determine whether it is excessive and determine what steps can be taken to remedy the condition.

"There is a heat balance for the plant as a whole and one for each individual piece of equipment. Due to the fact that the efficiency of boilers, turbines, engines and other equipment changes with the load, a complete and exact heat balance is good for only one specified load and one combination of



Sandy McNair—never quite right after being shipwrecked—pounded a lot of practical engineering into Jim's head before he passed on

equipment. Also the determination of a complete heat balance is often a difficult and expensive procedure.

"Fortunately, however, most of the losses or, let us say, items of the heat balance remain relatively constant so that once a plant or single piece of equipment is completely tested, the losses determined, segregated and reduced to a practical minimum, those losses are of no further interest to you as long as the performance is up to par. Get the point? No?

"Well, you test a boiler. It takes you two, maybe three, days. You work out a complete heat balance for perhaps several loads and then draw an efficiency curve. You wouldn't want to do that every week or even every month. No. What you do is analyze the coal occasionally to be sure it stays relatively constant, measure the coal burned, the steam produced and its temperature and pressure.

"There's your input and output, their ratio is the efficiency and as long as it stays up to par you don't worry any more about the losses. For practical purposes your heat balance has been reduced from perhaps a dozen to two items. You go through the plant like that with each piece of equipment, pick out the significant items and combine them all in one simplified plant heat balance which neglects all the minor losses.

"From an operating standpoint you then put in sufficient instruments and arrange a log sheet so that if your overall efficiency drops off you can quickly spot the piece of equipment at fault, or, detect feedwater or other conditions that may eventually lead to trouble.

"If you're ambitious you may even draw up a heat balance either in diagrammatic or tabular form for several different loads, or you may summarize your results by days, weeks or months so as to give you a better picture of what you are doing.

"This is a sort of skeleton heat balance and what will answer your purpose may not answer the next man's, so he does it differently. If you generate only electric power it will probably be quite simple, if you supply both steam and power, especially with a

combination of back pressure and condensing operation, it may be quite elaborate.

"Fundamentally, however, a real heat balance is a tool for the plant designer. It shows how the several pieces of equipment operate together, tells what the plant should do if everything works as expected and serves as a means of comparing several designs from the standpoint of cost and performance. It often costs more to save heat, you know, than the heat is actually worth.

"The heat balance should, of course, set a bogey for actual plant operation, but unfortunately not every piece of equipment will work exactly as expected, and, the design heat balance usually has to be corrected from actual tests to give a true comparison of plant operation. This sounds simple but often is very difficult because you cannot always test a piece of equipment, operating under exactly the same conditions or piped up exactly the same way as it is in actual operation.

"It is well, however, to make as complete a heat balance as practical from time to time, for this is the best way to make studies as to where improvements can be made. Unfortunately, steam loads and power loads do not remain fixed, and the ratio between them changes constantly so that a good heat balance today may be a poor one next month or next year. In other words, you should review the design of your plant from time to time as well as be sure that you are getting all you can out of what you now have. Therefore, boys, a heat balance so exact and definite on paper may, in practice, turn out to be anything you wish—don't worry about it—but use it judiciously."

Since then we have worked out a good many together—paper plants and actual plants—and these old papers and notes cover a detailed history of both our plants over almost a quarter of a century. Perhaps we can go over some of them some night. So long, and thanks for the lift.

(Next month—How the extraction turbine increases cycle efficiency and why electric drive for auxiliaries is more efficient than steam drive.)

MECHANICAL POWER TRANSMISSION

Belt Slip and Its Cost

By W. F. Schaphorst

It is well known that all belts slip, but the amount of slip is not so well known and its determination has been more or less of a mystery.

So that any belt user can compute the slip of any drive, the following formula has been developed; it gives the percentage of slip in any belt:

$$S = 100 - \frac{100\,n\,(d+t)}{N\,(D+t)}$$

Where:

S = per cent slip.

n = r.p.m. of the driven pulley.

N = r.p.m. of the driving pulley

d = diameter in inches of the driven pulley.

D = diameter in inches of the driving pulley.

t = thickness of the belt in inches.

If the belts are transmitting full power, no matter how carefully you are attending to them, you will always get an answer to your problem, due to the elasticity of the belt.

If the answer is two per cent or less you can consider your belts in "good condition" as far as slip is concerned. But if the result is much greater than two per cent, there is something wrong—the slip is excessive and perhaps entirely too expensive, consuming power, as it does, year in and year out.

To compute the cost of the excessive slip for one year, use this formula:

Cost of excessive belt slip per year in dollars $= \left((0.98 - \frac{n\,(d+t)}{N\,(D+t)} \right) \times PCHW$

Where:

P = hp. delivered by the engine to the driving pulley.

C = cost in dollars of one hp. per hr.

H = running hours per day.

W = working days per year.

For V-belts the above formulas apply equally well excepting that:

d = pitch diameter in inches of the driven sheave.

D = pitch diameter in inches of the driving sheave.

t = zero.

Recently an engineer declared that where the cost of belt slip is only 80 cents per week, the money loss is so small that it isn't enough to pay the cost of a conference. In other words, he maintained that for 80 cents per week belt slip "isn't worth talking about."

The writer, however, does not agree with such a contention. Eighty cents a week, according to arithmetic, amounts to $41.60 a year, for which amount of money two or more well paid executives can profitably confer for several hours.

Exact vs. Approximate Belt Length Calculations

By Norman J. Mecklem
Engineering Department
L. H. Gilmer Company

Design engineers often ask "What is the difference between exact and approximate belt length?" Too frequently the question is avoided by belt salesmen, for while most of them know that the general formula is approximate, few know how or why.

For example, about a year ago a drive was set up in northern New Jersey consisting of a generator driven by two Diesel engines. The engines, each carrying a six E groove pulley, were set in concrete; the generator, with a twelve E groove pulley, was set midway between them. All the adjustment was on the middle unit, or generator. Center distances were figured so that standard belt lengths of about 300 in. could be used, and the whole drive checked perfectly by the approximate formula.

Trouble developed when the belts were installed. It was found that if one set of belts was tight, the other was loose and carried no load. According to an exact formula, each set of belts was about 1½ in. too long. This, of course, was only ½ per cent, but when one set was tightened, there was 3 in. of slack in the other. Normally, ½ per cent means little to a belt drive, but here was one case where the exact formula should have been used.

There is only one exact formula for belt length, but it may be expressed in many ways. The following development based on the dimensions, arcs and symbols shown by Fig. 1 gives a widely used form of this formula.

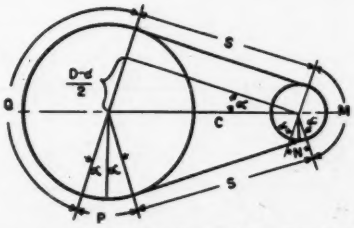


Fig 1. Showing the dimensions and symbols used in the development of the formulas

In Fig. 1, let

D = Diameter of large pulley
d = Diameter of small pulley
C = Center distance
L = Belt length

then it is apparent that

$(D - d)/C = \text{Sine } \alpha$

$S = C \text{ Cosine } \alpha$

$Q = \pi D/2$

$M + N = \pi d/2$

$P = \pi \alpha D/2$

$N = \pi \alpha d/2$

$L = 2S + Q + M + P$

$= 2C \text{ Cosine } \alpha + \frac{\pi}{2}(D + d) + P - N$

$= 2C \text{ Cosine } \alpha + \frac{\pi}{2}(D + d) + \frac{\pi \alpha}{180}(D - d)$ (1)

Since a great many of us have forgotten what trigonometry we once knew, a better formula is one which contains no reference to angles or their functions. Now, if we let

$$\frac{\pi\alpha}{180} - \frac{1-\cos\alpha}{\sin\alpha} = m,$$

and then add and subtract the value in (D — d) to the right hand member of Eq. 1, we have, L

$$= 2C\cos\alpha + \frac{\pi\alpha}{180}(D-d) - m(D-d) + \frac{\pi}{2}(D+d) + m(D-d)$$

$$= 2C\cos\alpha + \left(\frac{\pi\alpha}{180} - \frac{\pi\alpha}{180} + \frac{1-\cos\alpha}{\sin\alpha}\right)(D-d) + \frac{\pi}{2}(D+d) + m(D-d)$$

$$= 2C\cos\alpha + \frac{2C}{(D-d)}(1-\cos\alpha)(D-d) + \frac{\pi}{2}(D+d) + m(D-d)$$

$$L = 2C + \frac{\pi}{2}(D+d) + m(D-d) \qquad (2)$$

Equation 2 is also an exact formula, and can be used to advantage when the values of m are plotted against the angle α, or against the sine of α as expressed by (D — d)/C. This curve is shown in Fig. 2, labeled m_1. Thus, we have eliminated all reference to trigonometry, but have introduced a chart instead. This is a rational method of determining belt length, although it would be much more convenient if we could use a constant value for m and eliminate the necessity for a chart.

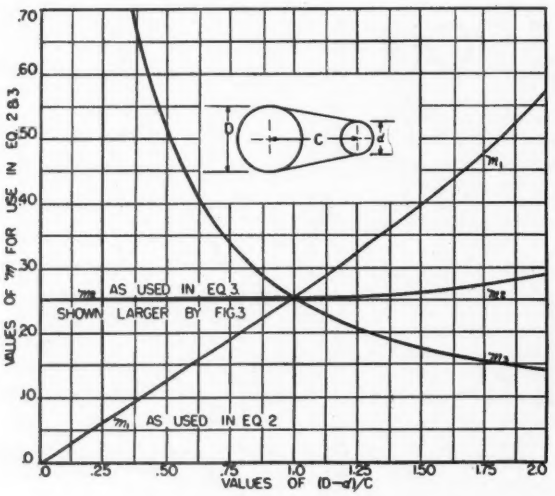


Fig. 2. Various values of the function m m_1 is for use with Eq. 2; m_2 (shown to larger scale in Fig. 3) for Eq. 3 is preferred

If we multiply and divide the last term of Eq. 2 by (2 sin α) we do not change its value and the equation remains correct.

$$m_1(D-d) = \frac{m_1}{2\sin\alpha}(D-d)\,2\sin\alpha$$

$$= \frac{m_1}{2\sin\alpha}\,\frac{(D-d)^2}{C}$$

If we let m_2

$$= \frac{m_1}{2\sin\alpha} = \frac{\pi\alpha}{360\sin\alpha} - \frac{1-\cos\alpha}{2\sin^2\alpha}$$

the belt length equation becomes

$$L = 2C + \frac{\pi}{2}(D+d) + m_2\frac{(D-d)^2}{C} \qquad (3)$$

As can be seen in Fig. 2, the curve obtained by plotting values of m_2 against D — d/C is much flatter than the curve for m_1, though it still slopes up to the right.

Similarly, if we let m_3

$$= \frac{m_2}{2\sin\alpha} = \frac{\pi\alpha}{720\sin^2\alpha} - \frac{1-\cos\alpha}{4\sin^3\alpha},$$

we have

$$L = 2C + \frac{\pi}{2}(D+d) + m_3\frac{(D-d)^3}{C^2}$$

The curve m_3 in Fig. 2 now slopes sharply down to the right.

Therefore, somewhere between m_2 and m_3 the curve assumes its flattest form and there is where we have the most constant values for m. Actually, it is never flat, but its nearest approach (where there is least difference between maximum and minimum values) occurs at the function of m equal to

$$\frac{\pi\alpha}{180\,(2\sin\alpha)^{1.032}} - \frac{1-\cos\alpha}{(2)^{1.032}(\sin^{2.032}\alpha)}$$

giving a belt length formula

$$L = 2C + \frac{\pi}{2}(D+d) + m\frac{(D-d)^{2.032}}{C^{1.032}} \qquad (4)$$

Although this is the flattest form of the curve, it is actually very little flatter than the curve m_2, since its values range from 0.279 to 0.255 to 0.279. It is not shown, as it would only confuse the curve m_2, and it is impractical to use such exponents as required by Eq. 4.

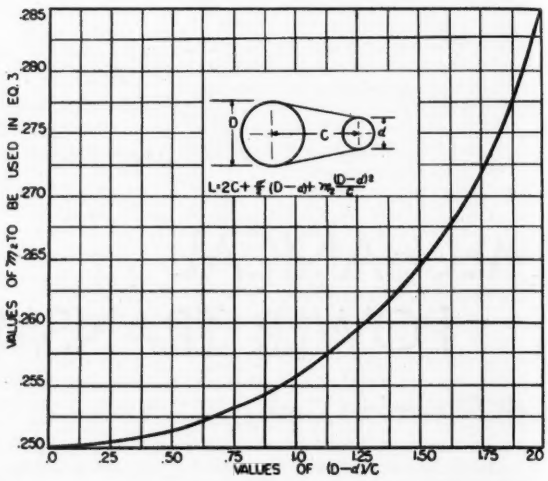


Fig. 3. Values of m to be used in very exact belt length calculation in Eq. 3. This is an enlargement of the m_2 in Fig. 2

Equation 3 has been chosen for general use since it is the only practical one with a nearly constant value of m. Figure 3 shows this function of m plotted to a more readable scale which will give accurate results when used with Eq. 3.

However, since most belt drives have an arc of contact greater than 130 deg., or a D — d/C value of less than 0.75, the upper end of the curve may be disregarded in a great majority of cases. A value for m of 0.251 has been chosen as nearly correct for most drives, and is used by most belt manufacturers in an approximate formula, reading

$$L = 2C + 1.571\,(D+d) + 0.251\frac{(D-d)^2}{C}. \qquad (5)$$

The difference between this and the exact formula is

$$(m - 0.251)\frac{(D-d)^2}{C}.$$

As can be seen from Fig. 3, this is negligible for small values of D — d/C. Only for drives with a large ratio and short center distance, or, for the more exacting fixed center drives, is it necessary to use the exact formula, that is the value of m from the chart, Fig. 3, used in Eq. 3.

FOR THE PLANT ELECTRICIAN

Advantages of Grounding Distribution Circuits

By H. A. Petersen
General Electric Co.

BASED upon theoretical considerations, results of numerous technical investigations, field tests, and broad experience, there are good engineering reasons for grounding distribution or other low-voltage circuits.

Switching surges are generally from 50 to 75 per cent more severe in the isolated neutral than in solidly grounded circuits. This is an especially important consideration when switching is done frequently such as in industrial plants or steel mills where motors may be started and stopped relatively often, or, when switching is done at the terminals of generators operating with neutral isolated.

Overvoltage resulting from blown sectionalizing or transformer fuses in combination with faults may occur in many of the isolated neutral circuits as now operated. It is believed that this fact, and the severity of switching surges discussed in the preceding item, account for most of the overvoltage difficulty experienced in isolated neutral systems, rather than the arcing ground which has been blamed for many difficulties in the past without adequate substantiating evidence.

In view of these facts, there is a logical argument for equipping isolated neutral systems with overvoltage protective equipment even in systems which are not exposed to lightning disturbances. Such procedure is more on the order of a pound of cure rather than an ounce of prevention, however, since overvoltages other than those caused by lightning can be avoided to a large extent by solidly grounding the system neutrals.

In any system properly equipped with overvoltage protection, it is logical to assume that voltages arising from any cause, whether it be lightning, switching, or other, will be limited to safe values. However, there is a substantial difference in the voltage protective level that can be held by arresters in an isolated system as compared with that which can be held in a solidly grounded system.

Arresters for use in isolated neutral systems must have full line-to-line voltage rating plus a suitable margin which will prevent the possibility of exceeding the arrester rating under line-to-ground fault cnoditions while arresters for use in solidly grounded systems can have a substantially lower voltage rating. For this reason, the protective level in the isolated neutral system is from 10 to 25 per cent higher than in the solidly grounded system.

In general, no distinction is made for equipment as to whether it is to be used on an isolated neutral or a solidly grounded system. Therefore, since all insulation life is a function of voltage and time, other things being equal, there is a logical argument for grounding even though arrester protection is provided.

Improving a Balky Ash Hoist Motor

By P. C. Ziemke

The insurance inspector frowned upon the makeshift motor cooling device but rewinding with glass insulation met his full approval. This, with spirals cut on the commutator, whipped the motor problem.

THERE are many hard working motors about an industrial plant and in all probability the ash conveyor rates tops in that respect. I recall an installation where the temperature rose to 180 deg. near the power house ceiling in summer and hovered in the high 90's all winter long. Such excessive heat coupled with grit and grime common to boiler plants raised hob with the conveyor motor. The situation required keeping a spare motor on hand at all times since a shutdown due to lack of ash disposal would have been unthinkable. Ventilation was not feasible because of the cramped conditions.

What seemed like a happy idea was the stunt of suspending some 30 ft. of Du Pont "Venitube" used in mine ventilating, on a line of galvanized wire up near the ceiling. Coupled to this was installed a blower connected to a 3-hp. motor. Well, it "was" a swell idea until the insurance company inspector spied the so-called fire proofed canvas. He suggested it be replaced with regulation sheet metal piping, but that would interfere with boiler repairs. Someone jokingly suggested the motor be wound with asbestos insulation. We had not heard of just that, but we investigated the possibilities of the new fibre glass insulation especially made for motor winding and field work.

On the first occasion that a burnout occurred the new insulation was ordered used. While it appeared prohibitive in price as compared to the older type, it proved to be all the manufacturer claimed for it. While it was the intention to reinsulate only the armature as the initial experiment we were prevailed upon by the electrical shop to discard the old field coils and replace these with new ones. Ripping several of them apart proved what poor risks they were and how their retention would have involved the newly insulated armature before long.

The reinsulated motor gave great promise since it ran without any immediate indication of giving trouble even though the ash removal task was for the time greatly increased. In fact the insulation did stand up under the gruelling heat, but the commutator showed signs of failing. The motor turned over at slightly under 400 r.p.m. and this comparatively slow speed failed to throw out brush grindings from the undercut mica insulated slots.

Sparking ceased when these were scraped clean, but the condition was soon repeated as new deposits of carbon collected. As an experiment (against the advice of the motor manufacturer) the commutator was turned down smooth and the carbon trouble was over. However, the development of high micas within a month indicated that our troubles were still not at an end.

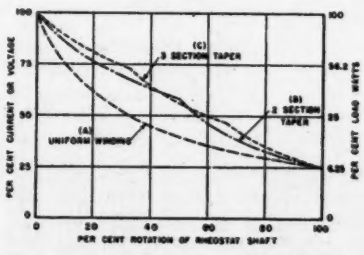
Cutting these down with commutator dressing stones was of course no big chore, but eventually went back to undercut micas and obtained fine commutator wear by cutting a spiral groove $\frac{1}{16}$ in. wide and $\frac{3}{32}$ in. deep on a pitch of two threads per inch in the copper. This kept the metal scored clear at all times and in combination with the glass insulation ended the ash hoist problem.

Why Taper Wound Rheostats Are Better

TAPER-WOUND rheostats offer several advantages over the uniformly wound type. In rheostats of this type, the wire is wound in two to five (or more) sections of diminishing wire or ribbon sizes. These sections are so smoothly joined that only the change in wire size tells where the sections connect.

For a given application, where an appreciable ratio between the maximum and minimum currents exists, the taper may accomplish one or more of the following: 1, provide more nearly linear control at all positions of the contact arm (see the curve); 2, make possible the use of a smaller rheostat; 3, make possible the winding of higher resistance on a given size rheostat; 4, make possible special curves of resistance versus rotation.

Because tapered windings involve extra manufacturing operations, tapered



Variation of values relative to shaft rotation for uniformly wound and taper-wound rheostats

rheostats when ordered singly or in small quantities generally cost more than uniformly wound rheostats or the next larger size. When larger quantities are involved the tapered unit generally becomes the more economical one.

The graph below shows how different values varies (in a typical case) with the per cent rotation of the rheostat contact on an Ohmite Mfg. Co. resistor. Because a uniformly wound rheostat adds a constant number of ohms per degree of rotation to a constantly increasing number of ohms, the current changes more slowly as the resistance is increased as in Curve A.

In a tapered winding, curves B and C, increasing the number of ohms per degree of rotation as the total ohms in circuit increases, makes the current curve more nearly linear. These curves clearly illustrate the advantage in using a tapered winding to obtain more uniform control of an electrical device.

BOILER AND STOKER OPERATION

How to Determine Forced Draft Air Requirements

By E. M. Sims

FORCED DRAFT air requirements may be calculated on the assumption that the theoretical weight of air for complete combustion of 1 lb. of different fuels is a constant per 10,000 B.t.u. in the fuel. Substantiating this assumption, is Table I, from *Steam Power Plant Engineering* by L. A. Harding.

Using this average value of 7.65, the theoretical weight of air required for complete combustion of one pound of fuel is:

$$W_{at} = (Hv \times 7.65) \div 10{,}000 \qquad (1)$$

where H_v is the heating value of the fuel in B.t.u. per lb. The weight of fuel burned per hour is:

$$W_f = \frac{(\text{B.hp.} \times 34.5 \times 970.3 \times 100)}{E \times H_v} \qquad (2)$$

where W_f is the weight of fuel burned per hr. in lb. B.hp. is the boiler hp. developed. E is the per cent efficiency of boiler and grate. H_v is the heating value of fuel in B.t.u. per lb.

Substituting the value of H_v in Eq. 1 in Eq. 2, W_f

$$= \frac{\text{B.hp.} \times 34.5 \times 970.3 \times 7.65 \times 100}{E \times W_{at} \times 10{,}000}$$

and $W_f \times W_{at}$

$$= \frac{\text{B.hp.} \times 34.5 \times 970.3 \times 7.65 \times 100}{E \times 10{,}000}$$

This last $W_f \times W_{at}$ is the weight of air theoretically required per hour. The volume of air to be handled (assuming 65 deg. F. as the average boiler room temperature, standard atmospheric pressure and the corresponding density of 0.075 lb. per cu. ft.) is in cubic feet per hour:

$$\frac{\text{B.hp.} \times 34.5 \times 970.3 \times 7.65 \times 100}{E \times 10{,}000 \times .075}$$

or in cubic feet per minute; the theoretical air requirements $(cfm)_t$ is

$$\frac{\text{B.hp.} \times 34.5 \times 970.3 \times 7.65 \times 100}{E \times 10{,}000 \times .075 \times 60}$$

The actual volume of air required $(cfm)_a$ is

$$\frac{\text{B.hp.} \times 34.5 \times 970.3 \times 7.65 \times 100 \times T}{E \times 10{,}000 \times .075 \times 60 \times 100}$$

where T is the per cent theoretical air or (100 + per cent excess air). Therefore, combining constants, the actual air required is:

$$(cfm)_a = 5.69 \times \frac{\text{B.hp.} \times T}{E}$$

Example. Determine the air a forced draft fan will be required to handle when supplying 60 per cent excess air to a boiler developing 1000 hp. with an overall efficiency of 85 per cent.

$$(cfm)_a = 5.69 \frac{1000 \times 160}{85} = 10{,}720$$

This is the example used in showing the method of solution on the chart. (See the chart page 108). If the boiler horsepower developed is larger than the limits of the chart, a smaller value may be assumed and the corresponding cfm of air multiplied by the ratio of the developed boiler horsepower to the assumed boiler horsepower.

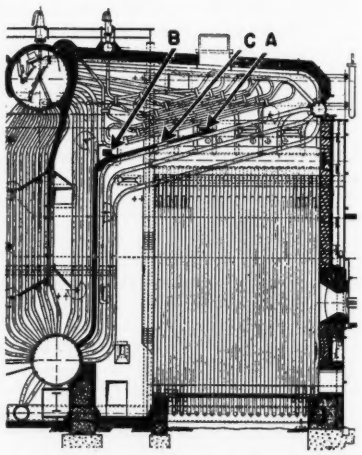
Table I. Theoretical Amount of Air Required for Different Fuels

Fuel	Composition-moisture included C	H	O	S	Ash	Moist. per lb. of fuel, in lb.	B.t.u. per lb. as Fired	Air per lb. of fuel, in lb.	Air per lb. of combustible, in lb.	Air per 10,000 B.t.u. in fuel, in lb.
N. Dak. lignite	0.394	0.068	0.438	0.007	0.093	0.362	6,700	5.0	9.2	7.54
Colo. lignite	0.578	0.060	0.310	0.004	0.048	0.207	9,941	7.5	9.9	7.53
Ill. bituminous	0.609	0.058	0.192	0.037	0.104	0.127	10,989	8.4	10.8	7.66
Ohio bituminous	0.705	0.054	0.112	0.029	0.100	0.052	12,733	9.7	11.2	7.63
Pa. bituminous	0.757	0.054	0.103	0.012	0.074	0.035	13,700	10.3	11.3	7.50
Pa. semi-bit.	0.807	0.043	0.032	0.014	0.104	0.012	14,096	10.8	12.0	7.65
W. Va. semi-bit.	0.843	0.047	0.052	0.007	0.051	0.031	14,688	11.2	12.1	7.65
Pa. anthr.	0.752	0.028	0.041	0.008	0.171	0.021	12,472	9.6	11.9	7.66
Cal. crude oil	0.866	0.116	0.000	0.008	0.010	0.000	18,565	14.1	14.2	7.59
									Av.	7.65

Cleaning Flat Baffles

IN ONE plant firing pulverized coal, trouble was encountered with soot collecting around the superheater tubes just above a gently sloping baffle.

The condition was improved by installing a cleanout door at B on one side of the boiler and using a 15 ft. steam lance once or twice a day. Conditions were further improved by adding the second door A at the nose of the baffle where not only the baffle but a good portion of the superheater could be cleaned as well.



Cleanout doors at A and B plus small gas bypasses in the baffle at C solved a troublesome problem on this boiler

Cutting three holes in the baffle as shown by C (one about 2 ft. from each side wall and one in the middle) also proved effective. The bypassed gases cause eddying currents which keep the soot from depositing on the tubes and thus assist in maintaining a clean superheater with good heat transfer at all times.

Notes on Chain Grate Stoker Operation

By Harold D. Brown

FIRST of the requirements for satisfactory and economical operation of any type of stoker is a furnace of proper design, well constructed and maintained. The side walls of the furnace for a chain grate must be kept as free from clinkers as far as possible by the use of a slice bar, but beyond this a slice bar should not be used on a chain grate because mixing the ash with the fuel will cause clinkers. An operator should watch for air leaks into the furnace and either report or repair them.

Usually an operator must use the furnace as constructed and fire accord-

ingly. The design and volume of the furnace and the amount of draft available set the limit for the amount of fuel that can be burned in a furnace. It is easy to keep a high CO_2 by using a thick fuel bed and putting part of the coal in the ash pit, but that is not efficient firing.

The depth of fuel at the gate of a chain grate stoker will depend upon the load to be carried on the boiler, the length of the grate, the fineness and ignition temperature of the coal, and the amount of draft used. Very few companies today will even consider paying the extra price for No. 2 nut or chestnut while even pea size is taboo on most chain grate jobs unless it is absolutely necessary to keep up steam pressures or prevent smoking. Use of these larger sizes only adds more waste to one of our great natural resources because screenings have to be disposed of at the mines.

Fuel Bed Thickness

Today 1½ in. and 1¼ in. screenings are more or less standard coal for chain grates. Loads of from 150 to 200 per cent of the rated boiler capacity are carried on many boilers equipped with chain grates and burning these small size screenings. With 1½ or 1¼ in. screenings on a grate, measuring 9 ft. from front to back and 6 ft. in width, a fuel depth of from 4 to 7 in. can be used. A 4 in. fuel bed will require about 0.15 in. of water draft over the fire. A 7 in. fuel bed will require about 0.4 in. draft over the fire.

No set rule can be made for the thickness of the fuel bed or the amount of draft to use. On a longer grate a slightly thicker fuel bed will have to be used and the coarser the coal the thicker the fuel bed will have to be. Some coals will require more draft than others. Only enough draft should be used to prevent smoking and to burn the coal that is necessary to carry the load on the boiler.

Thickness of the fuel bed should be set so that the fuel bed burns evenly across the grate and tapers off from the gate to a thin bed of live coals that burns out as it passes under the bridge-wall in the back. Yet, it should be thin enough so that the grate does not have to be slowed to the point where the fire burns out in holes. The grate, however, should run slow enough so that the arch over the gate keeps hot and the fire does not run away from the gate. The gate should be kept in condition so that it can be changed as the size of the coal changes.

Put Siftings Back Into Furnace

With the above method of setting and regulating chain grates I have been able to maintain a CO_2 record of from 9 to 14 per cent with very little combustible going into the ash pit. The coal that falls through the grates should be fed back to the grate in small quantities if possible so that it will burn without spoiling the fire.

A scoop shovel full of coal an hour does not seem like much coal to waste in an hour but it amounts to 20 lb. or 480 lb. per day or about a dollar a day. If someone were taking a dollar off your bank roll every day and throwing it to the kids in the street you would soon do something about it. The kids could use the dollar, but nobody can use the B.t.u.'s that go up the stack with excess air caused by too much draft, holes in the fire, and air leaks into the furnace or that go to the ash pit in unburned carbon.

As most plants around Chicago burn 1½ or 1¼ in. screenings it is necessary to wet the coal so that it does not fall through the grates. The coal should be wet enough so that it will stick together when squeezed into a ball in the hand. Wetting of fine coal usually improves combustion. In theory this should slow down combustion, but this is one of the things that does not work out according to theory. The beneficial action is probably part physical, giving better fuel bed conditions, and part chemical from the combination of the water vapor and the volatile matter from the coal reacting at high temperatures. I have not made tests with a fully equipped boiler so do not have figures on just how much the combustion rate can be increased by this means but many times I have been able to get the steam pressure in the plant up to where it should be by the simple expedient of wetting the coal.

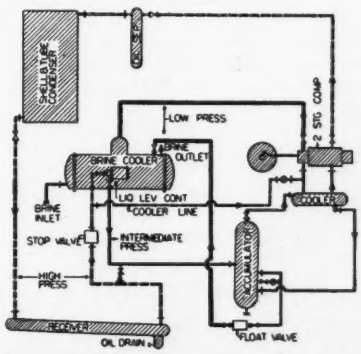
REFRIGERATING PRACTICE

A Two-Stage Automatically Operated Refrigerating Plant

SEVERAL new features are incorporated in a Sulzer 65 t. automatically controlled refrigeration unit installed in a Swiss chemical plant. A temperature of –8 deg. F. is maintained in a brine tank by circulation through a brine cooler by means of an electrically driven pump. The compressor operates through a temperature range of from –17 deg. F. in the evaporator (brine cooler) to +73 deg. F. in the condenser.

Both the compressor and brine pumps are automatically started and stopped by a thermostat in the brine tank. The compressor is equipped with clearance pockets to give half capacity at light load periods and can be brought from rest to full speed in 40 sec. It is driven by a slip ring motor through V-belts.

The shell and tube condenser may be supplied either with city water or water from a mechanical draft cooling tower. Both the ammonia system and circulating water system are controlled electrically in parallel with the compressor motor starter. With city water a magnetic valve stops the flow when the compressor stops. The cooling tower, the water pump and fan motors are also stopped. Time delay relays take care of proper sequence.



Piping diagram of an automatically controlled refrigerating unit as used in a Swiss chemical plant. Dotted piping is the high-pressure system, medium solid lines intermediate-pressure and heavy solid lines low-pressure. Flow of ammonia to the intermediate system is indirectly controlled by the liquid level in the low-pressure brine cooler

As shown by the drawing, three ammonia pressure systems are used, a high, intermediate and low (evaporator). All the liquid ammonia from the condenser flows to the receiver. From the receiver the flow is through the float control valve on the brine cooler, to the accumulator on the intermediate-pressure system.

Any ammonia evaporated during the expansion separates out in the accumulator, passes to the intercooler between the high and low-pressure cylinder and then to the suction of the high-pressure cylinder. Liquid ammonia falls to the bottom of the accumulator and under control of a float valve flows to the low-pressure brine cooler and from there to the compressor suction.

The control is thus indirect from the ammonia level in the low-pressure brine cooler, first to the intermediate and then to the low-pressure system. The stop valve in the high-pressure line is electrically operated in conjunction with the compressor. Gas temperature leaving the high-pressure cylinder is held to a maximum limit by automatically injecting liquid ammonia into the intercooler through the cooler line shown on the diagram.

Liquid ammonia collecting in the bottom of the intercooler flows by gravity into the accumulator. This accumulator, as well as the receiver, is equipped with an oil drain. Further controls to prevent damage under abnormal conditions consist of overload and low voltage trips; interruption of current if the motor fails to come up to speed; and cutouts if the cooling water fails or is insufficient.

Questions And Answers

We Apologize

DISAGREEABLE editors say they sometimes deliberately insert mistakes and errors to find out how observant and critical their readers are. We try to be very agreeable and assure you that the error in page numbers in the January issue was not deliberate. In that issue page 101 should have been 102 and 102 should have been 101. Please correct your last month's copy and look with forbearance on the poor editor.

Question No. 153

Will This Shut Down the Boiler?

WE ARE using two B.&W. cross drum, three pass boilers, each with 154 tubes 4 in. diam., 18 ft. long, 9 banks high and 14 wide. These are fired at about 200 per cent rating with a 37 per cent volatile soft coal on forced draft underfeed stokers.

Tubes have always been cleaned by a steam lance through blow holes in the side walls, but other equipment, just installed, now prevents the operator from reaching any part of the three lower rows of tubes in the first pass and the top three rows in the second pass with lance. Access to third pass is not interfered with.

What will be the result of leaving the accumulations of soot and ashes to remain on the tubes? T. R. E.

Question No. 154

Equalizing the Cutoff

WITH A heavy load the cutoff on our single eccentric engine is longer on the head end, but at light load they are equal. What can be do to get equal cutoffs at all loads?

Wrentham, Mass. J. Y.

Question No. 155

Wants Data on Steam Jet Refrigeration

I WOULD like very much to get some actual operating costs on steam jet refrigeration. What is the total cost per ton of refrigeration produced? How are the steam costs affected by the pressures used, or is it more desirable to use high-pressure superheated steam or low-pressure saturated steam for a vacuum of say 29.5 or 29.75 in.? How are costs affected when the water evaporated is not returned to the system? Is the ratio of heat (in the steam for the jets) supplied to the tons of refrigeration produced consistent for given conditions? How does it vary with load, with steam pressure and with vacuum? A. O. H.

Question No. 156

Calculation of Compressor Capacity

WILL you tell me the capacity or tonnage of our York ammonia compressor? It is a two-cylinder, 12½ by 14½ in. machine driven at 258 r.p.m. by a 300-hp. motor. W. J. F.

YOU probably understand that we can give you only an approximate value for the refrigerating tonnage of the compressor you specify from the data you submit. You give no information regarding head pressures or suction pressure or other conditions that would affect the capacity of the unit.

The displacement in cubic feet of a compressor (with no allowance for volumetric efficiency) is given by the following formula:

$C = (r^2 \times 3.1416 \times S \times r.p.m.) \div 1728$

where C is the displacement in cubic feet per minute; r the radius of the cylinder in inches; S the length of the stroke in inches.

Your machine is a 2 cylinder 12½ by 14½ in. unit operating at 258 r.p.m. The radius is 12.5 ÷ 2 or 6.25 in. Then substituting (and solving with a slide rule)

$C = [(6.25)^2 \times 3.1416 \times 14.5 \times 258] \div 1728$
$= (39.06 \times 3.1416 \times 14.5 \times 258) \div 1728$
$= 266$ cu. ft. per min.

Since it is a 2-cylinder machine, the total capacity will be twice the above figure, or 532 cu. ft.

Under general conditions with zero suction pressure, 4 cu. ft. per minute gives a gross refrigerating effect of about 1 t. or 288,000 B.t.u. in 24 hr. This in the question is equivalent to 532 ÷ 4 or 133 t. of refrigerating capacity in 24 hr. Of this, from 0.4 to 0.6 is available as actual ice making capacity, so the ice making capacity of the machine in question is about 65 t., more or less.

Answer to No. 140

What About This Indicator Card?

OLD TIMERS! What a howl that prefix to the question brought—we apologize—apparently, indicators are still used by young and old just as energetically and effectively as they were 30 yr. ago.

The original inquiry sent in by A. A. Thieme of Richmond, Va., and printed on p. 91 of the November issue, asked for criticism of an indicator card taken with a 60 lb. spring from a double eccentric 18x30 in. Hamilton Corliss,

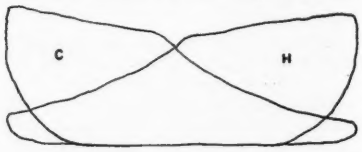


Fig. 1. This card here reduced to half size, appeared full size on p. 91 of the November issue

operating at 120 lb. pressure, 15 lb. back pressure, and 150 r.p.m., driving a 300 kv-a. generator and synchronized with the utility system no less! The card (reduced to half the original size) shown by the accompanying cut is for a load of 240 kv.

Nothing To It When You Know How

IN THE study of Indicator Diagrams and in the operation of stationary steam engines, we must decide first of all whether or not we have a satisfactorily performing engine, is the engine operating smoothly, or do we have a characteristic knock or bump at the end of the stroke, or do the bearings have a tendency to run warm? These are some of the indications that the valve setting may not be correct for the particular operating conditions under which the engine is required to perform.

Generally speaking, the indicator diagrams shown are not bad. I have seen many diagrams very much worse than these—in fact, some diagrams I have seen, one would wonder how in the world the engine ran at all. There is nevertheless room to improve these diagrams if Mr. Thieme has a particular tendency to approach perfection as near as possible. The area of the head end diagram appears slightly larger than that of the crank and this must be caused by a slightly later point of cut-off for the head end.

Release is late on both ends, but particularly so on the head end. Compression is higher for the head end than for the crank end and compression on both ends is too high for good practice with regard to Corliss engine valve setting. However, the speed of 150 r.p.m. is a little higher than usual for this type of engine, therefore one can expect a higher compression setting to be necessary so that the compression as shown may be O.K. to obtain a smooth running engine. Admission also appears a trifle late, but not seriously so.

In an effort to improve the indicator card, I would suggest changing the length of the exhaust valve rod for the head end so as to obtain an earlier release which will in turn reduce the compression on the head end; use the same procedure for the crank end and follow this procedure until the release

on both ends is alike. When this is accomplished, I believe the compression will also balance on both ends.

If the compression under the new setting is not quite high enough and this lack of compression is observed by a slight bump or knock as the engine passes the centers, the exhaust eccentric should be moved forward on the shaft slightly. This will make the release still earlier and the compression earlier and if shifting the eccentric makes the release too early, the exhaust valve rods can then be lengthened, slightly, which will bring the release back to correct condition and also build up the compression as well.

The point of cut-off should be equalized and if either side should be unequal the heavy side should preferably be on the crank end to offset for the loss of area due to the piston rod on the crank end side of the piston. The admission valve rods could be adjusted so as to bring a little earlier valve opening for admission. This could also be done by moving the eccentric slightly ahead on the shift.

Care should be exercised, however, in adjusting the point of admission for the reason that too early admission may also produce a tendency to knock while passing the centers. The gradual downward tendency of the steam line indicates a shortage of steam supply through the steam admission valve into the cylinder; that is, as the piston moves forward on its stroke, the supply of steam into the cylinder is not enough to keep the pressure up to the proper level.

This might be the result of a very long steam line from the boiler to the engine or there may be several bends in the steam line and there may be a globe valve at the boiler header instead of gate valves. These possible causes can be determined by the operator himself and his own knowledge will guide him as to the possible cause of this insufficient steam supply.

There is, however, another viewpoint. The piston may be leaking badly and if so, the steam would blow by the piston and out the open exhaust valve on the other side of the piston, however, the expansion curve and the compression curve do not seem to bear out this thought and it is therefore more likely that the supply of steam is insufficient rather than that the piston is leaking badly.

For myself, I have always been old fashioned enough to desire a visible test for piston leakage by placing the engine on the crank end dead center and by opening the indicator valves from the head end—by slightly opening the throttle valve, steam is admitted to the crank end of the cylinder and if the piston leaks, steam will blow out of the indicator connections from the head end; the piston can then be placed on the head and dead center and checked in a similar manner for leakage at that point.

This same procedure can be followed to check the piston for leakage at intermediate positions along the stroke, but in this case it is necessary to securely block the fly-wheel so that it cannot rotate when the steam is turned on. By this method of procedure it is possible to determine whether or not the piston leaks. Steam and exhaust valves can be checked for leakage by placing the engine on exact dead center so that it cannot rotate when steam is turned on.

Open both indicator cocks and with steam valves in closed position, open the throttle valve—if steam valves leak, steam will blow out of both indicator cocks. To check exhaust valves for leakage, first remove both steam valves and replace the steam valve caps, place exhaust valves in closed position and open the throttle valve. If exhaust valves leak, the flow of steam passing these valves will easily be heard and according to the piping system, it may be easy to observe this steam coming out of the exhaust head.

HARRY W. BENTON
Plant Engineer
Pratt & Whitney Div.
Niles-Bement-Pond Co.

Offers a 10 Per Cent Savings in Steam

INFORMATION accompanying the indicator diagram submitted by Mr. Thieme does not correspond with the figures obtained from the card's measurements[1]. Mr. Thieme gives 120 lb. steam pressure and 15 lb. back pressure although from the size of the card shown, and using a 60 lb. spring, it would seem that the steam pressure was about 92.5 lb. and the back pressure 7.5 lb. Furthermore, the load is given as 240-kw. while the indicated horsepower is only 276.5, or about 205-kw.

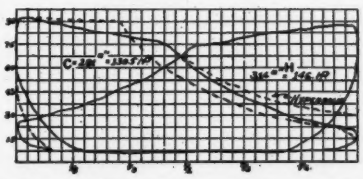


Fig. 2. A 10 per cent steam savings is estimated if the card were corrected as shown by the dotted lines

From the appearance of the card it is my opinion that repeated adjustments have been made to eliminate lost motion due to wear in the valve gear with no regard for the resulting effects on the valves' setting. The movement of the valves with relation to the ports has been changed just as continual keying up on a crank-pin will change the movement of the piston with relation to the heads.

This has resulted in the steam valves giving insufficient opening for proper lead and the steam line of the card drops off due to wire drawing (although some of the droop is no doubt due to leaking piston and/or leaking exhaust valves). These conditions can be corrected by adjusting the length of the steam valve rods to give greater port opening, roughly negative lap should equal about ¼ port width.

Distribution of work between the cylinders should be equalized by adjustment of the governor reach rods. The shape of the expansion and compression lines would indicate leaking exhaust valves or piston, or both, but improvement would require reboring, etc.

The very late release and excessively early compression are caused by too much exhaust lap. The present amount of compression is not necessary and is merely a waste of power, as it reduces the area of the card that should be obtained.

I believe that about a ten percent saving in steam consumption would be effected by making the steam line more nearly horizontal and reducing the compression. These two changes shown dotted on the crank end card should bring the cut-off back to about ⅓ stroke from the present ½ (approx.) stroke, with the same load and pressures.

It would be interesting to learn what action is taken and the outcome.

Melrose, Mass. E. MACDERMOD

But Here—No Savings in Steam, Says an Old Timer Who Hasn't Turned Grey Yet[2]

BY ATTEMPTING this analysis, I am admitting that I am an old timer—however, the first fault I find with this diagram is the absence of atmospheric line.[1] Oh, yes, there is a line there all right, but evidently it was not made from the stroke of the engine in question, as it is much longer than the diagram itself. This line is always a great help in squaring, measuring, and dividing the card. Otherwise, I would say that this is a very good card, and that there are many engines in operation that do not equal this one.

However, the expansion line on head end indicates that the admission valve is blowing some steam by, also the cut-off on head end is at center line of cylinder, while that of crank end is 2½ in. before center. This could be corrected by blocking the governor in cut-off positions and moving cut-off of crank end up 1¼ in., or that of head end back 1¼ in. In either case the result would be the same.

It is common practice with many engineers to have their engine valves set exactly opposite to this card, that is, to have the cut-off occur slightly earlier on the head end, giving longer admission on the crank end to compensate for the difference in area of

[1]Apology No. 2 (No. 1 was about the Old Timer's crack). It should have been definitely stated that the card was reproduced full size, although this was an obvious assumption, for there would have been no point in giving the spring scale for a card that had been reduced in size to some unknown scale.

Mr. MacDermod's calculations of steam pressures are 7.5 lb. low because he assumed a backpressure of 7.5 instead of 15 lb. as stated in the original question. This mistake is justified because the engraver, in an attempt to be helpful, tooled off the atmospheric line which seemed to him superfluous. The omission of the line was missed by the proofreader and what appears to be the atmospheric line on the card is simply a rule used to separate the card from the text. This also answers Mr. Barnes' later criticism of the length and position of this line on the card as originally reproduced.

[2]He suggests, however, that the grease and soot may account for that.

the head and crank ends, due to the space taken up by the piston rod. However, in case of an engine with a tail rod this difference is very small.

Another contention is that the engine should exert the greatest power against the frame. I personally don't agree with this, as any amount of difference in power between the head and crank end of the cylinder will tend to set up vibration, cause a sensitive governor to hunt, and otherwise do more damage than good.

Again, I will again say that this is a very good card, and since a back pressure of 15 lb. must be maintained it is obvious that there is some live steam make-up added to the exhaust. Assuming this, the only advantage to be gained by a better valve setting would be about 4 per cent more load-carrying capacity of the engine. Reducing the pounds of steam per horsepower on the engine at the same load will also reduce the number of pounds of steam exhaust from the engine, and more live steam will need to be added to the exhaust to maintain equal back pressure. This would result in a small gain in temperature due to the superheat of the reduced steam.

Leavenworth, Kan. A. H. BARNES.

We Repeat—It Was to Full Scale

IF THE CARD as published is to scale, there is a bad restriction in steam line between gage and cylinder. It is impossible to check the expansion curve for valve and ring leakage unless the

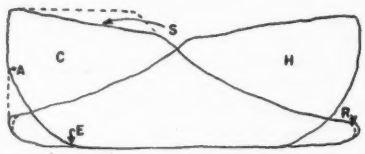


Fig. 3. Mr. Porters criticism. A, late admission. S, slope caused by late admission (slow valve opening). R, release a trifle late. E, early compression. C and H indicate the crank and head end cards respectively

card is to scale—i. e., full size. Is it? Head end cut-off is longer than crank end, otherwise both ends show same errors in setting.

Rock Hill, S. C. J. C. PORTER.

A Mere Beginner Horns In—Only 20-Odd Years' Experience, tsk, tsk.

WITH BUT twenty some years of experience, I do not class myself as an old timer, but if the Old Timers will excuse me, I would like to horn in, and submit this brief diagnosis.

Both expansion lines are too straight, which indicates leaky valves, perhaps a leaky piston or maybe a little of both. The steam line shows excessive drop, which may indicate too small a steam line between boiler and engine, although a leaky piston and leaky exhaust valves would also cause such a condition.

Cut-off is not as sharp as it should be, also indicating leaky admission valves; admission is late on both ends, especially on crank end, and there is too much compression on both ends.

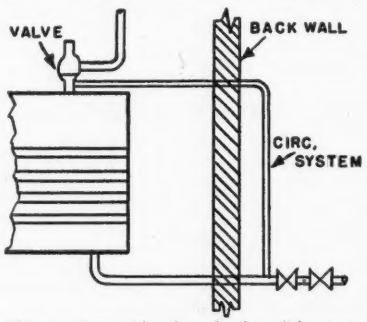
Then my prescription is: increase lead on both ends; reduce compression on both ends; make all four valves and piston tight; then the old mill should percolate much better. However, if this does not correct the steam line entirely I would recommend raising steam pressure, or increasing capacity of steam line between boiler and engine.

Columbus, O. G. BROWNING.

Answer to No. 125

Well, Blow Me Down, What a Hookup

C. W. Z. installed a new 285-hp. H.r.t. boiler with a "blowdown circulating system," as shown in the sketch. It didn't circulate and the unprotected pipe burned badly. He asked, on p. 92 of the August issue, five direct ques-



This circulating blowdown hookup did not circulate as it was supposed to and consequently caused trouble

tions dealing with the theory; necessity for protecting pipes from direct heat; and on feedwater treatment. Other answers appeared on pp. 98 and 99 of the December issue and pp. 99 and 110 of the January issue.

A Settling Basin Is Suggested

1. THERE IS no circulation for condensate in drop leg, which would tend to effect this, is of such a quantity as to be ineffective. Remove the "circulation" pipe.

2. The blowdown pipe should certainly be protected from the heat.

3. The advisability of using river water depends upon the river. Generally, the answer is—No!

4. Any impurities that found their way to the blowdown pipe would have an excellent chance to bake on, due to heavy concentrations and lack of circulation, even though the pipe were protected.

5. What degree of treatment do you desire, and for what? Mud removal? Hardness? Scale? Embrittlement? Fill a few jars with feedwater, note time required for various amounts of silt to settle out. Determine the percentage amount of silt you want to dispose of, and note the time required for its settlement in the jar. From this time and the maximum number of cubic feet of feedwater required, the proper size of detention basin can be determined. A properly placed baffle will allow the construction of a smaller basin to accomplish the same result.

Reducing the velocity to about 1 ft. per sec. through the basin will remove approximately 90 per cent of the settleable solids. Naturally, these are rough figures, as the amount of deposit depends upon the size of the particles, the length and cross sectional area of the basin, temperature of the water, as well as the rate of flow.

While the calculations leading to the determination of the size and shape, and location of baffles in such a basin are rather involved, and a certain number of experiments are in order, nevertheless, in a plant of the size indicated, a rough and ready sort of engineering will prove very effective and satisfactory. Just be on the safe side, make the basin large enough, not forgetting to provide a blowdown for the removal of settled solids, or else install a by-pass, so the silt can be removed by means of a shovel gang.

As no definite information is given, a specific type of chemical treatment cannot be recommended. However, we believe that a type of internal treatment, whereby the undesirable impurities are flocculated and precipitated in the boiler, then blown out, would be indicated. This type of treatment is highly satisfactory, its success depending upon the proper analysis of the feedwater, and an earnest and conscientious application to the problem by the operator. "Outside" treatment, from a standpoint of cost of apparatus, would likely prove too expensive for this plant.

Wingdale, N. Y. SAM WILLIAMS.

When in Doubt Treat the Water—But How About Feeding Through the Blowoff Line?

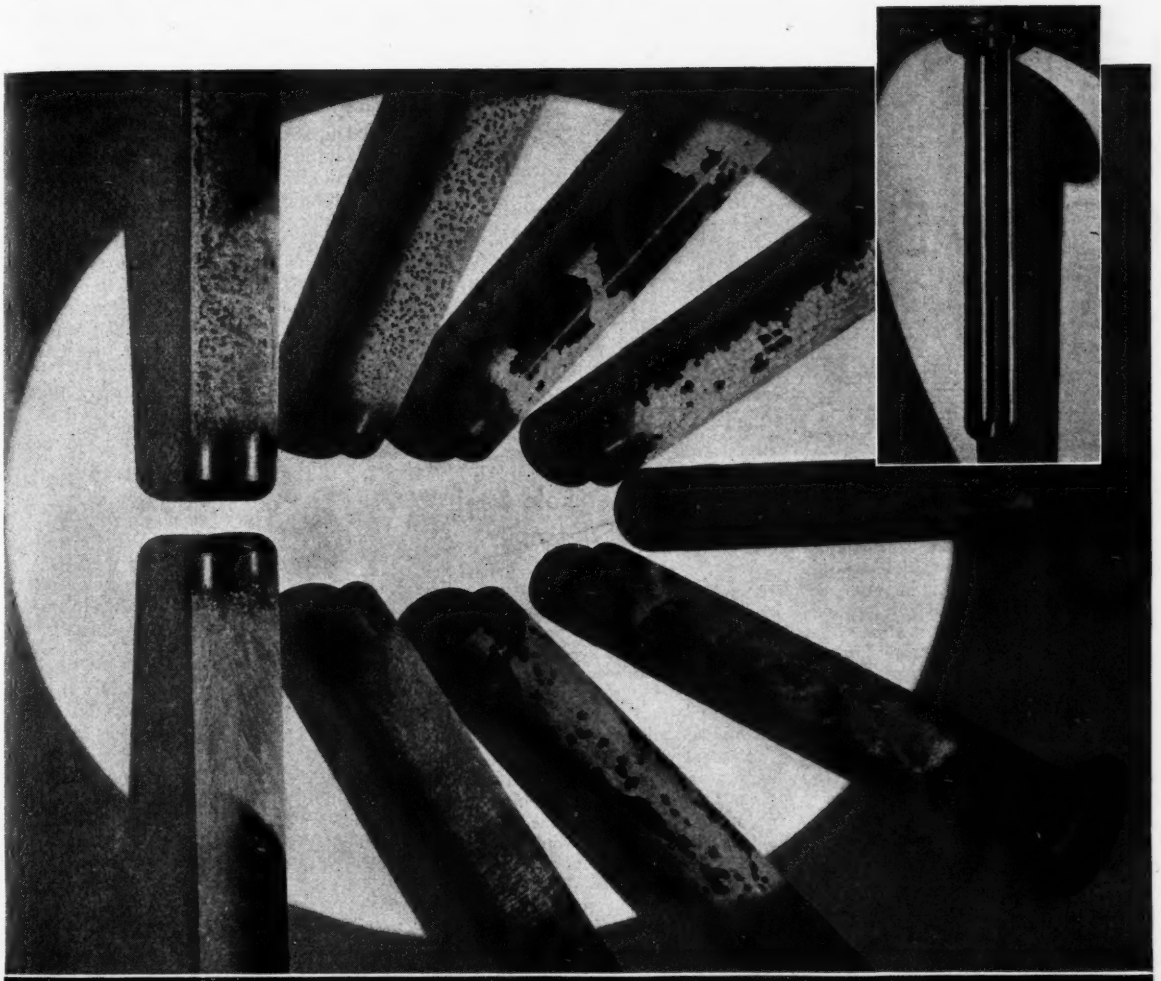
THEORETICALLY the scheme should work because the pipe on the outside of the back wall would fill with condensation and this condensation being cooler than the water in the boiler it will circulate through the blow line. But since in the case of question it does not work then there is not enough circulation to do any good.

My advice is to do away with the circulating system and solve the problem in a different way. The blow line was burned because of the scale in it and the scale was there because the water was not treated. If there was scale in the blow line there must be much more on the flues and my guess is that the loss is about 10 per cent of the fuel cost.

That means $2000, if his annual fuel cost is $20,000. For $100 or $200 per year, C. W. Z. can treat the water so as to eliminate all scale. I would recommend internal treatment with compound from any reliable concern.

That should solve his problem with burned blow lines. But if the blow line should burn notwithstanding, build a brick "V" column in front of it to protect it from the direct impingment of the flame. Will also add that in many boilers of that construction the feedwater is made to enter the boiler through the blow line and this is a sure proof against burned blow-off lines.

Chicago, Ill. N. T. PEP.



SPOTLIGHT ON *Destruction*

SCALE can mean eventual boiler destruction, and the time to stop it is *before* it forms on expensive power plant equipment. These tubes, taken from high pressure miniature test boilers in the Nalco Laboratories, spotlight corrosion and incrustation destruction. Study of the deposit formed here with samples of your feedwater is one important means used by Nalco Engineers in preventing damage and inefficiency in your plant equipment.

Costly experimentation with feedwater treatments has no place in plants using the Nalco System. From a thorough Nalco Survey, your plant is provided with a "made-to-measure" system that is permanent insurance against all water treatment difficulties. Write for full information.

Above: *Sample tubes from the Nalco Laboratories, showing a variety of dangerous scale formations.*

Inset: *A clean, new boiler test tube, ready to tell the whole truth about your feedwater, and what it does to your boiler tubes.*

NATIONAL ALUMINATE CORPORATION
6224 West 66th Place **Chicago, Illinois**

Canadian inquiries should be addressed to
Aluminate Chemicals, Ltd., 555 Eastern Avenue, Toronto, Ontario

The Complete Water Treating Service

Nalco

LETTERS AND COMMENTS

The Navy Needs

AMONG many other things, the Navy needs naval architects, many, of course, but right now there is a particular need for a few with sufficient experience and background to check and correct specifications. The men meeting the requests will be given commissions.

This is a little out of the power plant field but P. E. & E. goes to many strange places. If you feel you are qualified, or have acquaintances that are, write to the P. E. & E. editor at once for information as to where to apply.

He Starts the Ball Rolling for Uncle Sam

CONGRATULATIONS upon your assignment for the coming year. It is going to be a real pleasure to work with you through the turbulent days for you are in the position whereby you can speak through your columns to the men who are really the backbone of our war effort.

The more practical ideas which pass through your hands for editing, the better the chances for the publishing of worthwhile information. We've got to keep our plants running at peak efficiencies and with minimum shutdowns to fill our obligations and do our part while the country is fighting for its life.

My contribution in this program will be submitting a series of articles to help speed up operation and reduce unit down time. J. C. D.

Our Hat Is Off to Reggie —He's a 95.7 Percenter

L. A. DUNBAR, Supervisor of Apprentices, Aluminum Co. of America, Massena, N. Y., just sent in $2 with a request that we enter a 1 yr. subscription to POWER PLANT ENGINEERING for Reginald Jarvis, because, said Mr. Dunbar,

"Mr. Jarvis is given this personal subscription as a token of accomplishment in maintaining the high rating of 95.7 per cent for an average of 4 yr. of study in our Industrial Electricity Class conducted at the A. C. O. A. Apprentice School."

The Law and a Gold Seal Frustrate A Scotsman

MY PEEVES are plentiful and I can wax more or less eloquently by the hour on many subjects, but these are slight and more or less petty compared with the real ache given me by the recent Amendment to the Massachusetts Engineer's License Law, brought to mind by the License Law mentioned in the December issue, p. 84.

When I was a callow youth, a stripling so as to speak, it was my wont to hang around engine and boiler rooms for, occasionally, when the men were in good humor, they would allow me to clean out the ash pits or wipe up the engine flywheels. In addition to these privileges I would sometimes be addressed by that exalted personage, the CHIEF, who one day took me into his office and showed me a lavish display of impressive looking documents each with a gold, red, blue, or green seal and all mounted under glass in a frame.

The Chief explained the meaning of these "tickets" to me and emphasized their importance with the result that then and there my life's ambition was born; some day I, Mrs. E.'s only son S., would be a Chief and have an office with a desk, to put my feet on and to keep a quart in, a gaboon to aim at but never hit, and one of those Papers with the Big Gold Seal.

Having made my dire, or doleful, decision I thereupon obtained a position (?) in a boiler room. It was not long, however, before I learned that there was a being far more powerful and exalted than the Chief and that was the State Boiler Inspector or Examiner, the guy who would say Yea or Nay to my feeble attempts at betterment.

With diligence and perseverence I prepared myself for an examination as second class fireman, even foregoing all sleep on the night shift, for the indomitable E— spirit was fired with zeal to obtain that Paper with the Big Gold Seal.

Finally came the fateful day. Imagine my thoughts and feelings of awe as I sat before the Great Man examining me. After a sufficient pause to instil in me the proper respect and reverence for his presence he growled, "Would you or would you not allow a fusible plug to remain in a boiler after a year's service? Come, come, my dear young fellow, tell me the truth."

"Oh, no sir," I simpered abjectedly. "I could never break the law." During the examination the thought was running through my mind—"How in the world did Jim Watt ever manage to invent the steam engine without the direction of this super person and his ilk. In fact, how had he dared to—"

Mr. Pomposity finally deigned to scrawl my name on a fireman's license after extracting my solemn promise that I would not load the engineer's pipe with oily waste if I found it around, nor put gunk from the sump-well in the chief's shoes, which I had never done anyhow, but they were ideas. When I floated down the State House stairs it was literally on hot air.

Well, the years slid by and the Examiners' chests slid down and I made more or less regular walks up the State House steps, sometimes successfully, sometimes unsuccessfully, but always a step nearer to that Paper with the Big Gold Seal. Never again did I get a Paper on the first crack with one exception, a boiler inspector's ticket that had a gold seal but couldn't be considered in the same class with the One.

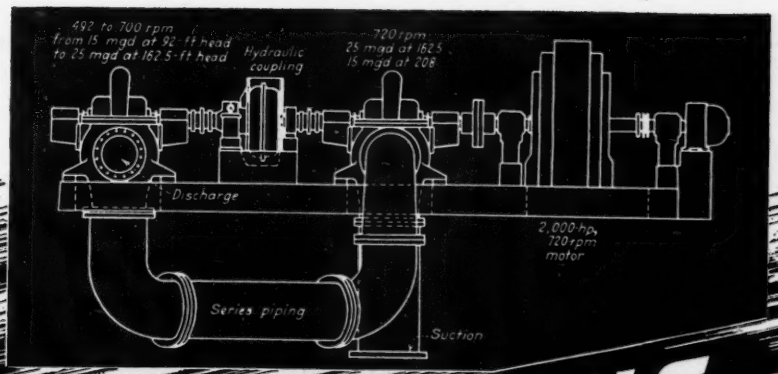
And then came a series of blows. First they jacked up the application fee from one to seven bucks which made it too expensive to wear the examiners down by going up so often that they got disgusted and said "Let's give it to him and get rid of him for a while." No more would that get me a ticket. I didn't make enough money to follow that system.

The next blow was moving the Department, due to lack of space, from the State House to an ex-grogshop down the street. My morale suffered. It seemed wrong to go to that spot to be examined when I was accustomed to going there for congratulations or consolation after an inquisition.

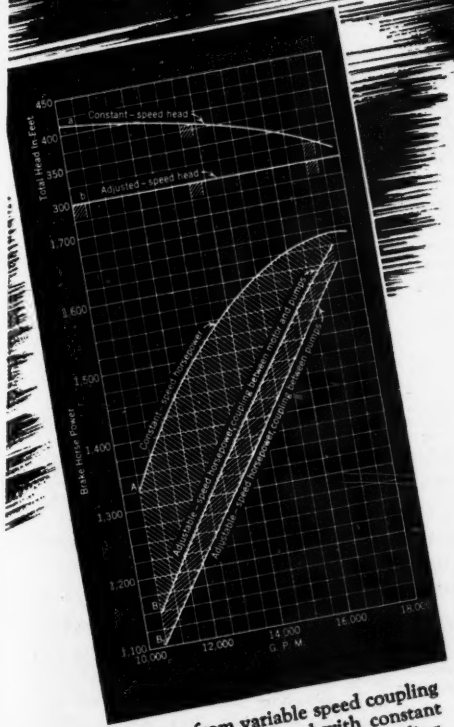
But all this was trivial when came a real blow, to wit, NO MORE FIRST CLASS TICKETS WITH GOLD SEALS. The State had to economize. The effects were well nigh disastrous. I couldn't sleep while on the night trick and even forgot my lunch once or twice. Finally a faithful and boon companion brought me back to as near normal as I'll probably ever be by remarking that they still dealt out those Papers (although sparingly) and that I could remove the gold seal from my boiler inspector's ticket by the use of a little steam and attach said seal to the Paper when and if I ever got it. I didn't like that last crack but appreciated the logic and so my spirits revived.

But NOW to cap all my previous and what I considered insurmountable difficulties in the pathway to my goal, comes the final, the most devastating blow of all. It isn't the buck a year it's going to cost, although a buck is a buck and I'm part Scotch. I'm even willing, but not eager, to help the good

Variable speed coupling between pumps.



Variable SPEED COUPLING with DE LAVAL PUMPS saves power!



Saving from variable speed coupling as compared with constant speed and throttling.

The *head developed* by a centrifugal pump at constant speed is greatest at shut-off and *falls off* with increased delivery.

The *head required*, as, for example, when delivering into a piping system or when feeding boilers, *increases* with flow.

With De Laval turbine-driven pumps these requirements can easily be met by varying the speed, but with A. C. motor-driven pumps the alternative is throttling, which is wasteful of power. D. C. motors are expensive, while variable speed A. C. motors are uneconomical.

However, where two or more pump stages can be used, it is necessary to vary the speed of one pump only, as is done in the De Laval variable speed coupling arrangement here shown.

The loss from slippage affects only the power taken by the variable speed pump and is much less than the power that would be wasted by throttling a constant speed pump or by varying the speed of both pumps by means of a hydraulic or magnetic coupling to get the same flow and pressure relations in the discharge pipe.

The inter-pump coupling, of either the hydraulic or the electro-magnetic type, can be controlled manually or automatically to maintain the desired pressure conditions in the pump discharge line.

Write for Bulletin M-11, giving full particulars.

HYDRAULIC INSTITUTE U.S.A. MEMBER

DE LAVAL Steam Turbine Co.
TRENTON, N. J.

MANUFACTURERS OF TURBINES STEAM, HYDRAULIC PUMPS CENTRIFUGAL PROPELLER ROTARY DISPLACEMENT MOTOR MOUNTED MIXED FLOW CLOGLESS SELF PRIMING CENTRIFUGAL BLOWERS and COMPRESSORS GEARS WORM HELICAL and FLEXIBLE COUPLINGS

old Commonwealth pay for its extravagances, BUT, there won't be no more nice big white licenses with FIRST CLASS ENGINEER printed on them anymore and I won't have one to stick my gold seal on. I won't ever have a paper with the Big Gold Seal.

My years of striving and not succeeding have gone a'gley and 'twas all for naught; the new tickets are too big to put in your pocket and too small to frame, the different grades are different colors, one looks like a permit to keep 5 gal. of gasoline in your cellar, and the red one looks like a quarantine sign. The orange and green ones will cause an uprising among South Boston Irish engineers, and no one can foretell what the future will bring.

FRUSTRATED.

No Smokestacks?—Then What Use Are Barometers?

AFTER READING S. E. W.'s article on (p. 97, December) the very best way of finding the height of a smoke stack and then reading the latest war news in the papers I am beginning to wonder if it is not time to start figuring ways and means of doing away with this target for enemy planes. According to the reports given out by our government, we just lost one of our large battle wagons because of a direct hit on the stack. Could not this same thing happen to our industrial and power plants? One bomb and it would not have to be a direct hit on the stack, could put a whole plant out of commission for some time.

With our modern forced and induced draft fans could it not be possible to eliminate this aerial target which can be seen from miles away by enemy bombers? This may sound foolish and impractical to some people. I believe that it is possible and practical and could be worked out. There must be some way that flue gases can be filtered and smoke eliminated enough so that they may be discharged at a low level without being a menace to the health of the surrounding community. The forced and induced draft fans could be made to compensate for any losses due to the elimination of the high stacks.

If the stack was removed from our plants it would be a much simpler task to make them bomb-proof by building false roofs over them strong enough to take the impact of the bomb and explode it before it crashed into the plant proper. These false roofs should be made so that they could be easily repaired after the raid was over or the next morning and be all set for the next air raid.

As I stated before, this may sound foolish, but the first line of defense is no longer in the front line trenches, but in our factories and plants where implements of war are being made. In this war the country which keeps its factories working and the supply lines moving is going to come out on top and that is going to be us.

Therefore, we must be on our toes and uncover every weak point in our home front and make them our strongest points. The time to do that is today, not tomorrow or the next day because then the bombs may be falling and it will be too late. Looking at our factories and power plants through a bomb sight I think that the stacks which rise high above them is one of the weak points in our home defense and it is about time something is done about it regardless of expense.

Poughkeepsie, N. Y.

DONALD OSTERHOUDT.

EDITOR'S NOTE: *Smoke stacks as such cannot well be hid, yet at night when the bombing danger is greatest they are made noticeable largely by the trail of smoke. This can be obviated by intentionally using considerably more excess air than efficiency warrants. In special cases the stack and smoke may be used for deception, using a stack several hundred feet from the plant proper as is done by many western smelters. Power plants are good targets, often bombed and frequently hit, yet experience shows that with proper protection of main units, with the plant divided by walls, to localize the explosion and flying debris, the serious damage is relatively small.*

Pete Feuds With the Ex-Ed

(An uncensored, undated P.P.S. from Pete to A.W.K. probably following "Engineers Are Funny That Way" in the October issue—a sort of mental indigestion brought on by a mixture of women, mountains, goats, engineers, fans, slide-rules and vitamins. Incidentally, Mr. Fry of the F.C.C. did clamp down on both the OM and XYL on account he wants to make it tough on the Japs to pick up gossip. R. H. M.)

P. P. S. As for you and your mountain climbing!!! . . . double phooey. (Anyway that's pfui.) I thought you has grown out of the age when you walks around on all fours, but I sees where I is wrong. I supposes now you wishes you had a tail too for to hang on better with. Listen, when I goes duck shooting or tuna fishing I gets something to eat out of it . . . maybe. What does you do with the top of a mountain when you gets it . . . fry it or boil it?

Another thing I wants to know is how much you gotta pay the guide what dangles down a rope for to pull you "mountain climbers" up with. And what does you call a mountain . . . Bunker Hill, Blueberry Hill, or Conservatory Hill? And if you really wants to get to the top of one of them warts why don't you use a blimp. You don't give me no details like I gives you.

And now its glamor in your statistics you want . . . Eleanor Holmes and Gypsy Roses no less. Now look here, I has been doing my best to keep your department up to its immoral level. And what does you do, you wants statistics that has got to be figured with both hands in the dark. Next you'll be wanting I should get you telephone numbers. Now, I asks you one question: Where did you spend all your time at the Chicago Fair and didn't you think her fans was superfluous?

Well, here's hoping the F.C.C. don't get you for modulating your 5 watts of raw A.C. with the back door buzzer.

PULVERIZER PETE.

Tindin' Wather

IN THE course of our travels we once knew an old Irish water tender who had no sympathy for modern methods of firing. He not only held in contempt the young upstarts who attempted to teach him the fundamentals of combustion, but had quite fantastic ideas of the evaporation rate which he and his buddies maintained in the good old days. His philosophy is expressed in the following:

Oi've been afther tindin' wather for
almost thoity year,
An' ye can't expict a felly not to be
a bit way queer.
Things ain't what they used t' be
NO—not fer loikes o' Pat and me.

Toimes hev changed—all good things
they must pass.
All we used to do wuz kape the wather
in the glass.
If we kept the foir a burnin' an' the
steam a hundred twinty,
That wuz wurrk—an' wurrk a plenty.

But now, wid all the poomps an' meth-
ers, an' the fancy ricords we kape,
Bedod, we niver, niver git a chancet
t' slape.
There's Bintoori an' Ellison, Foxboro
an' Hays,
Mither uv Moses—me poor brain's in
a daze.

Talk uv sixteen pounds o' wather fer
ivery pound o' ile,
Go back and hoold your harses—me
blood begins t' bile.
Thot's the great big diff'rence between
thoity year an' now.
It takes the ould, ould toimers t' show
youse woise guys how.

Sivinteen—thot wuz aizy an' twinty
wuz the rule;
Oi may be ould and doty, but bejabbers
Oi'm no fule.
Fer Oi'm the mon, me bucko—Oi kin
make thim bilers talk,
An' Oi'll make yer expirts dizzy—
Oi'll make 'em stand and gawk.

Ye hear thim talk uv Bay Tay Uze
an' factors, iffishuncy an' such,
But Oi'll till ye smart young fellers,
ye ain't so very much!
Fer Oi've been tindin' wather fer
almost thoity year
An' Oi'll be dommed if Oi don't know
me bizness—don't yez iver fear.

By J. R. DARNELL.

Don't Forget the Operator

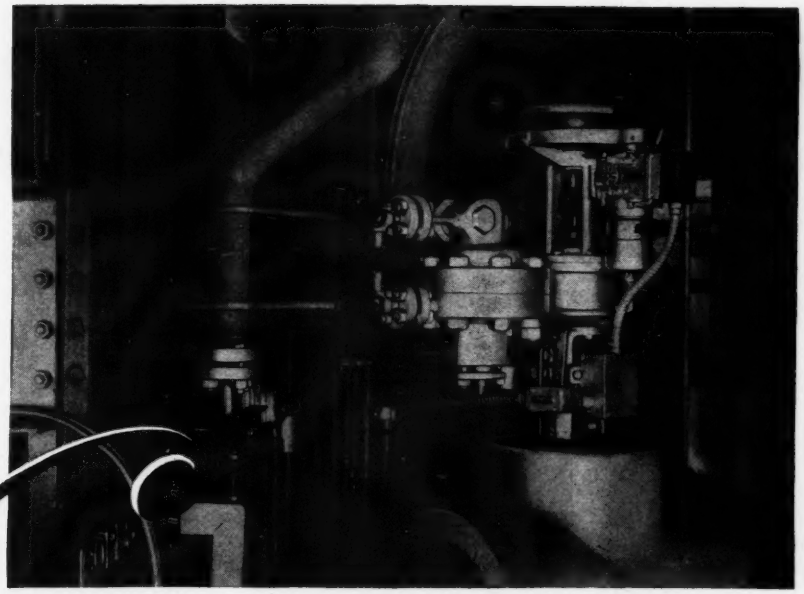
THERE IS one thing I would like to bring to the attention of manufacturers, many of whom take an undue credit for machinery which has given many years of continuous service. No one will deny that it is a record for the manufacturer to be proud of, *but* it is also a record for the operating personnel to be proud of. Obviously such machinery or equipment has been fortunate enough to be in the hands of a man (or men) who kept it clean, inspected it, maintained it and who really knew what they were doing.

Lansing, Mich. ARTHUR F. CHURCHILL.

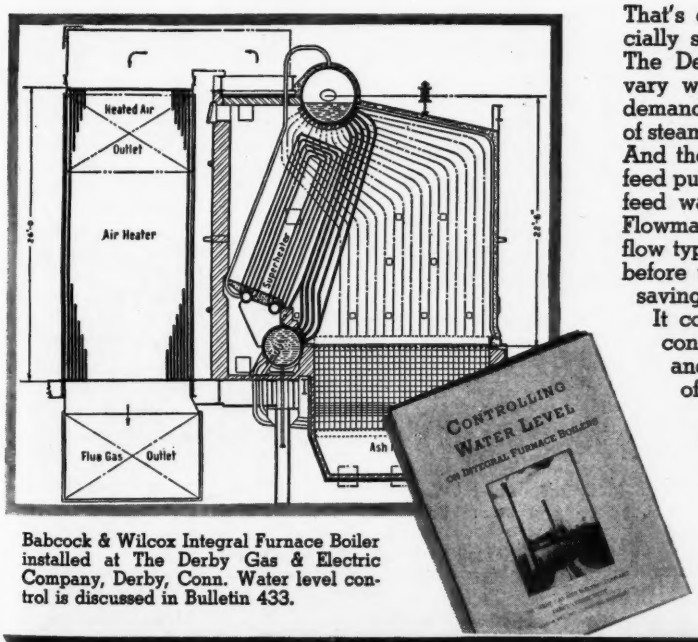
At The

DERBY GAS AND ELECTRIC COMPANY

Two 675-lb. 750-deg. B & W Integral Furnace Boilers with constant fluctuations in demands from industrial plants for power and steam at boiler pressure. Designed for 125,000 lb. an hr., with peaks of 150,000 lb. an hr. Fired with oil (normal) or powdered coal. Make-up about 25%. Gibbs & Hill, Inc., consultants.



COPES FLOWMATIC HOLDS WATER LEVEL ±1 INCH . . . .



Babcock & Wilcox Integral Furnace Boiler installed at The Derby Gas & Electric Company, Derby, Conn. Water level control is discussed in Bulletin 433.

That's close control on any boiler—and especially so on the two integral furnace units at The Derby Gas & Electric Company. Loads vary widely because of fluctuating industrial demands. Make-up is about 25 percent because of steam sold at boiler pressure to nearby plants. And there is no pressure control on the boiler feed pumps. Difficult conditions for an ordinary feed water regulator—but not for the COPES Flowmatic. This simplified two element steam-flow type regulator began to pay for itself even before the boilers were in regular service, by saving time in getting the new units on the line. It continues to return benefits by accurate control with no more than routine inspection and care. Write for Bulletin 433—the story of this interesting installation.

NORTHERN EQUIPMENT COMPANY
222 Grove Drive, Erie, Pa.

Feed Water Regulators, Pump Governors, Differential Valves, Liquid Level Controls, Reducing Valves, Desuperheaters

COPES — FEEDS BOILER ACCORDING TO STEAM FLOW-AUTOMATICALLY

★ GET CLOSER LEVEL CONTROL WITH THE FLOWMATIC ★ REGULATOR

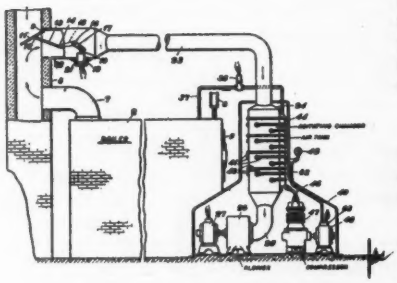
RECENT PATENTS
For Power Plant Apparatus

Copies of patents may be obtained from the Commissioner of Patents, Washington, D. C. Give the patent number, patent title and inventor's name. All patents are 10 ct. a copy payable in coin or money order. To facilitate purchase coupon books (each coupon good for one patent) may be purchased; 20 coupons for $2; or 100 coupons for $10

Compiled by J. R. Darnell

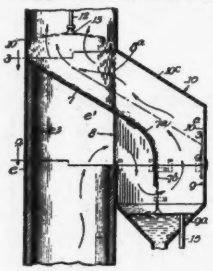
2,264,294. FUEL ECONOMIZING SYSTEM AND APPARATUS. George J. Byrne, Chicago, Ill., assignor to Byrnes Hot Draft Corporation, a corporation of Ill.

1. In an apparatus of the character described, means providing a mixing chamber, means including a plurality of nozzles for supplying steam and air under pressure into said mixing chamber for commingling with products of combustion contained in said chamber, said nozzles being arranged at spaced places circumferentially of the chamber, means for connecting said chamber with a furnace outlet, means for connecting said chamber with the draft inlet of a furnace, and means operative at a predetermined steam pressure for cutting off the supply of steam and air from said chamber.



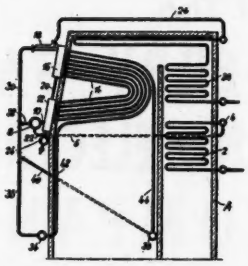
2,265,227. STACK FOR FURNACES. Oscar L. Coffey, Harvey, Ill., assignor to Whiting Corporation, Harvey, Ill., a corporation of Ill.

1. In apparatus for cleaning combustion gases, a vertically extending conduit for the gases having an opening in one side thereof, a downwardly inclined deflector extending from one side of and completely across the conduit and through the opening intermediate its upper and lower ends and beyond the other side of the conduit and having a vertically depending terminal extending below the lower end of the opening, for directing all the gases through the lower portion of the opening and downwardly at said other side of the conduit ,a housing offset and projecting only from said other side of the conduit and forming a passage for directing the gases from the lower portion of the opening and along the under side of the projecting portion of the deflector around the lower end of and over the top face of the deflector and through the upper portion of the opening back into the continuation of the conduit above the deflector, and a spraying device above the opening, for discharging water transversely across the conduit above the deflector so the gases in the conduit flowing upwardly from the deflector will pass through the spray and so that water from the spray will flow over the upper face of and cool the deflector, the lower portion of the housing being extended to form a water-receiving chamber below the vertically depending terminal of the deflector.



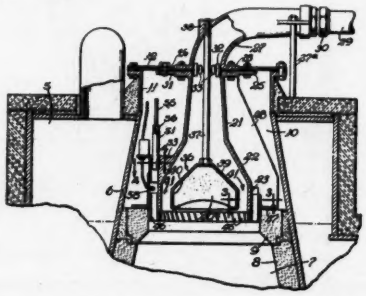
2,265,481. HEAVY DUTY HIGH PRESSURE DRUMLESS BOILER. Otto Hartmann, Kassel-Wilhelmshohe, Germany.

1. In a heavy duty high pressure drumless steam boiler, a vaporizing system comprising a plurality of vaporizer tubes arranged in tube groups, a separate collecting conduit for each group of tubes, individual steam and water separators for and joined to said conduits, each separator including a substantially horizontally disposed tubular portion for conducting a steam and water mixture and a steam takeoff portion joined outwardly of said tubular portion, and means for conducting the water from said separator to the tube group for that separator for recirculation therethrough.



2,267,025. PULVERIZED FUEL BURNER. Aubrey J. Grindle, Chicago, Ill.

2. In a pulverized fuel burner for use in a vertical combustion chamber, a combustion ring having a circular opening supported at the top of the combustion chamber, a nozzle having one end disposed in said opening and coacting with said ring to define an annular orifice for discharging a hollow cylindrical stream of secondary air into the burner, means co-operating with said nozzle to form an annular fuel orifice concentric with said air orifice for discharging a hollow cylindrical stream of primary air and entrained pulverized fuel into the combustion chamber, a metal ring supported on said combustion ring and encircling said air orifice, a series of vanes formed around the inner edge of said metal ring and positioned in said air orifice, said vanes being inclined relative to the axis of the orifice to impart a rotative movement to the secondary air stream, and means formed integrally with said nozzle for holding said metal ring in fixed position.



RECENT PATENTS FOR POWER PLANT APPARATUS

Pat. No.	Inventor	Title	Company Assignee
2,263,705	C. Seippel	Gas Turbine Plant	Brown, Boveri Co.
2,263,985	W. G. H. Finch	Power Transmitting Mechanism	
2,264,248	T. O. Schrader, Jr.	Apparatus for Purifying Steam From Steam Generators	Erie City Iron Works
2,264,551	H. C. Rateau	Refractory Lining for Furnaces	American Arch Co.
2,264,599	R. B. Stephenson	Boiler Feed System	
2,264,753	E. Henkel	Pump Control Valve	Superheater Co.
2,264,963	W. J. Regar	Self-priming Centrifugal Pump	
2,265,962	T. B. Montgomery	Prime Mover Control System	Allis-Chalmers Co.
2,266,162	A. B. Carlton	Heating and Distribution Plant	
2,266,272	I. Ruderman	Wave Driven Prime Mover	
2,266,312	R. M. Dilworth	Power Plant Output Regulator	General Motors Cor.
2,266,323	L. F. Kingery	Alternating Current Welder	Hickinbotham Bros.
2,266,371	J. J. M. Lee	Continuous Flow Reciprocating Pump	
2,266,945	C. F. Abraham	Screw Conveyor Drive Assembly	Screw Conveyor Cor.
2,267,027	R. M. Hardgrove	Fluid Heat Exchange Apparatus	Babcock & Wilcox
2,267,228	N. C. Woods	Valve Grinding Device	
2,267,262	L. F. Bast	Compressor and Vacuum Pump	Fuller Co.

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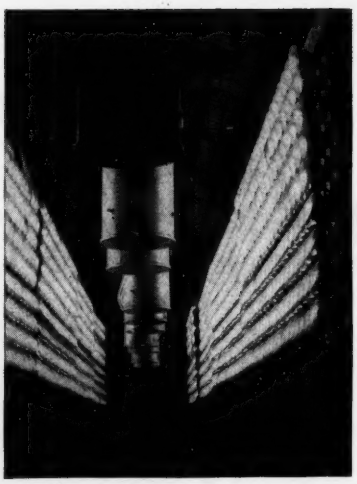
in flow measurement, we shall be glad to see that a copy is placed in your hands ● It is not a catalog . . . it is an illustrated specification of an ideal flow meter . . . a specification such as you would create if you had the time ● By this gage you are invited to judge any flow meter. The evidence as regards Cochrane Meters is presented to you for your eyes to see and your fingers to examine . . . and the section on where and how meters save money is a plant survey made right at your desk ● Just write Cochrane Corp., 3123 N. 17th Street, Philadelphia, Pa., and we shall arrange to have you examine this visual presentation at your own convenience.

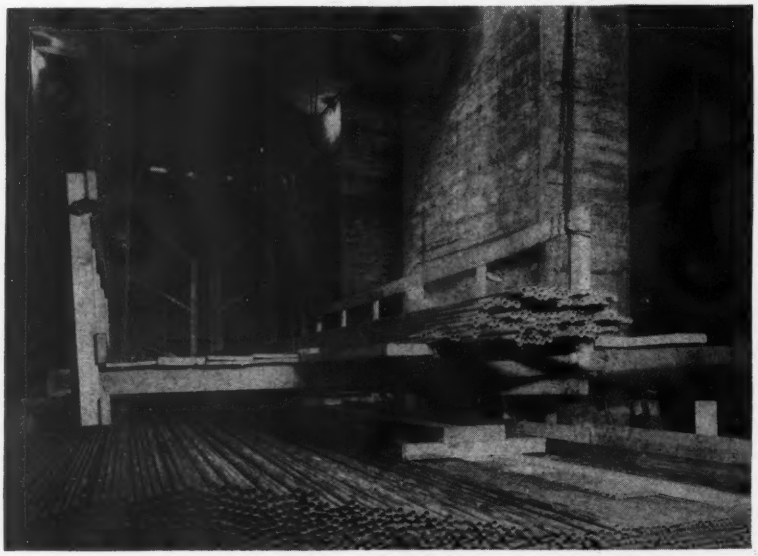
An interesting example of modern boiler room instrumentation is the above panel in the plant of Bigelow-Sanford Carpet Company at Thompsonville, Conn. where Cochrane Flow Meters are used to measure steam flow and pressure in association with Hays Draft Gages, Combustion Meters and Controls.

SHOP TALK

A department showing by means of photographs how engineers in various plants have overcome certain obstacles or devised methods to facilitate operation. If you have done something along similar lines that you are proud of or which you feel may be of interest to others, send us a picture and a paragraph of explanation. If the photograph is good and if the idea is original we will present it on this page and pay you for it.

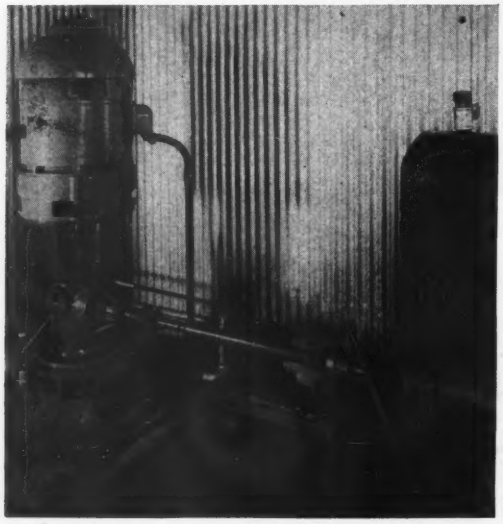


INFRA RED DRYING. This battery of 1368 infra red lamps arranged in two banks, 4 ft. high, and 32 ft. long, dries small transformer tanks in 8 min. at the Westinghouse Sharon, Pa., plant. The tanks, hung on an endless chain travelling 4 ft. per min., are sprayed inside and out just before entering the lamp banks. After this they are passed through a cooling chamber to bring the temperature to 150 deg., sprayed with finish coat and pass through another drying tank. The complete operation takes 25 min., or 6 to 8 times as fast as the former method. The lamps are 250 w. units and consume a total of some 342-kw.

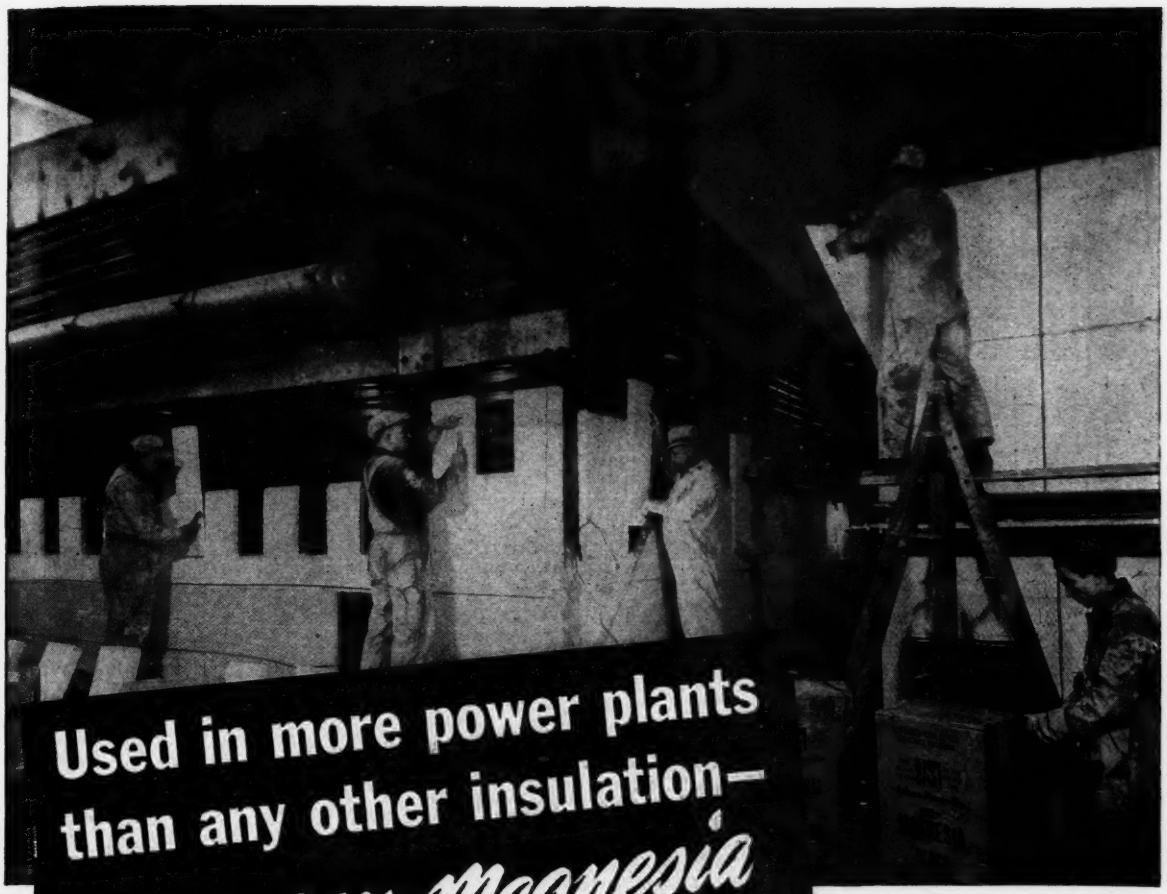


TUBING CONDENSERS. All ready to start installing practically 100 mi. of tubing in a 52,500 sq. ft. condenser at Philo Station. The 10,512, ⅞ in. Arsenal copper tubes, 24 ft. 11 in. long, will be rolled at both ends to reduce leakage. There are four tube support plates between the Muntz metal tube sheets. The condenser is a newly developed Foster Wheeler cross flow type and serves a new 85,000-kw. G.E. turbine. Note the convenient arrangement of the tubes and the movable platform supported from chain blocks so it can be raised to a convenient position.

CONDENSER BIB. Not all bibs are used in the nursery. Condensers, and in fact all cold water piping, have a nasty way of sweating at times. In this plant the problem was handled effectively by the bib or apron made from light sheet metal, arranged as shown, and draining to the sewer so as to keep the floor dry.



DUAL DRIVE. One of two deepwell pumps recently installed by Uncle Sam at Mather Field, near Sacramento, Cal. Normal operation is by a 30-hp., 1750 r.p.m. motor under float control, emergency operation by a 40-hp., 1740 r.p.m. Buda engine driving through a Johnson right angle gear unit, and a Watson-Spicer flexible needle bearing drive which will compensate for misalinement. A special non-reversing clutch makes it impossible to unscrew the pump shaft if the engine backfires. When the motor is operating the flexible drive between the pump and engine does not rotate. Pumps are Byron Jackson deepwell turbines with a capacity of 1000 g.p.m. each at 93 ft. head when driven at 1750 r.p.m.



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J-M 85% Magnesia

For power-plant service up to 600°, it's a habit with engineers to specify J-M 85% Magnesia Blocks and Pipe Insulation.

It's a good habit, too, they'll tell you, for no other material provides such satisfactory performance on the job. That's because J-M 85% Magnesia delivers the right combination of long life and high insulating value that means *permanently* efficient, economical service.

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Rock Cork Sheets

For refrigerated piping—
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For cold-water lines—
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For hot or cold service-water lines—
Pre-Shrunk Wool Felt Pipe Insulation

For low-pressure steam lines—
Pre-Shrunk Asbestocel Pipe Insulation

For steam lines to 700° F.—
Asbesto-Sponge Felted Pipe Insulation

For superheated steam lines—
Superex-Magnesia Combination Insulation

For furnace insulation—
Superex Blocks, Insulating Brick (3 types), Insulating Fire Brick (4 types), Sil-O-Cel C-3 Concrete

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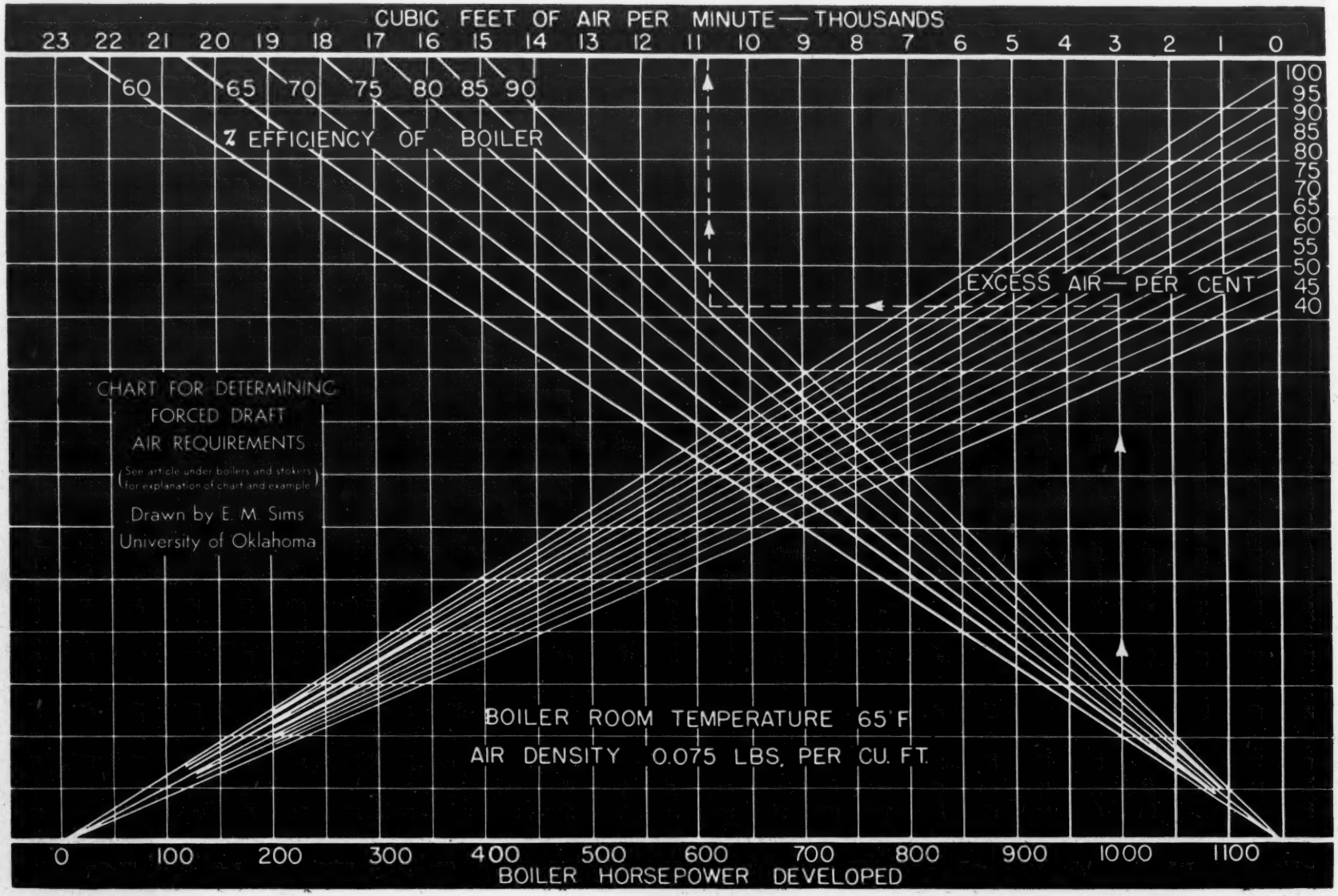
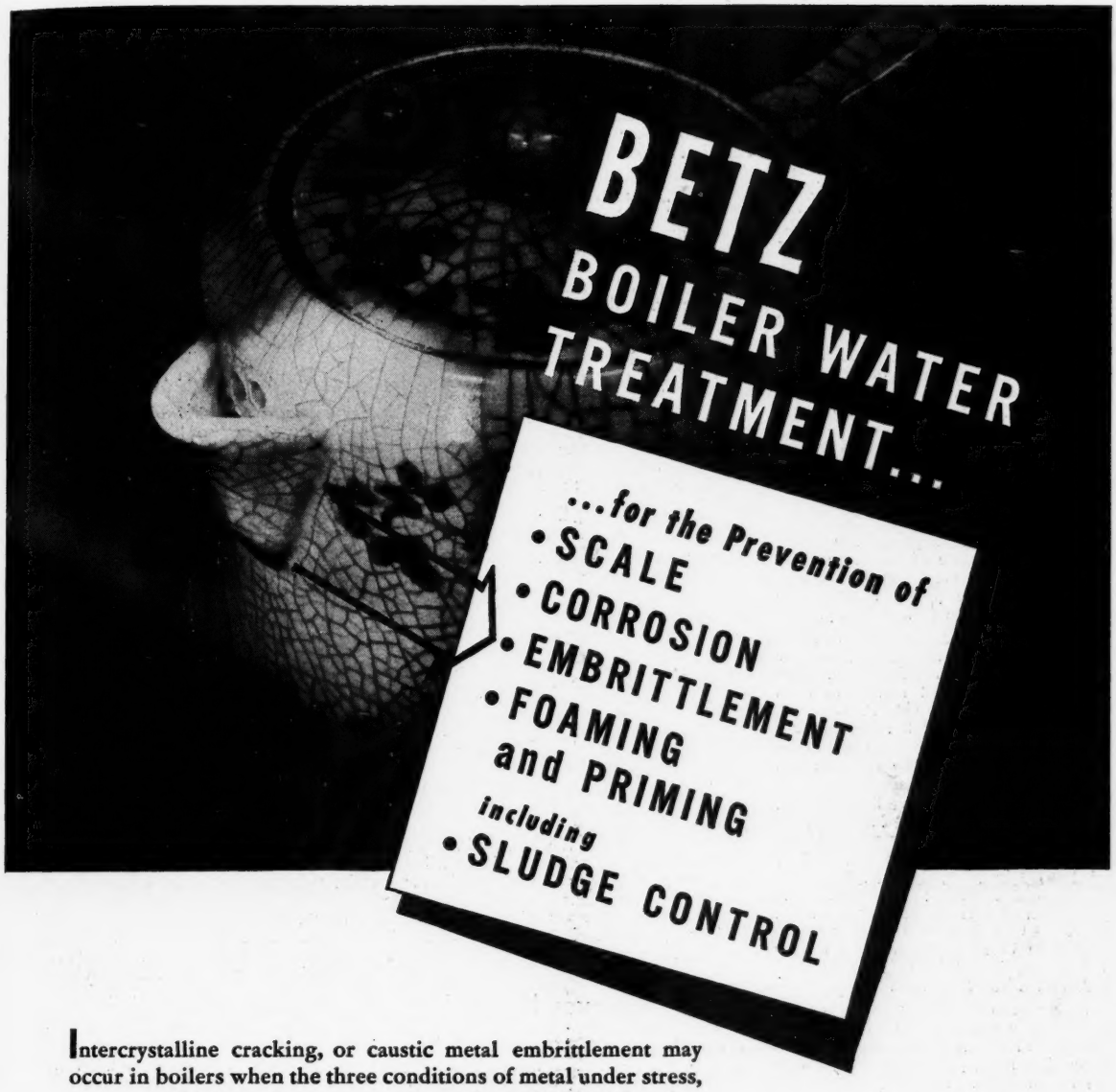

CUBIC FEET OF AIR PER MINUTE — THOUSANDS
23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
60 65 70 75 80 85 90
% EFFICIENCY OF BOILER
EXCESS AIR — PER CENT
100 95 90 85 80 75 70 65 60 55 50 45 40
CHART FOR DETERMINING FORCED DRAFT AIR REQUIREMENTS
(See article under boilers and stokers for explanation of chart and example)
Drawn by E. M. Sims
University of Oklahoma
BOILER ROOM TEMPERATURE 65° F
AIR DENSITY 0.075 LBS. PER CU. FT.
0 100 200 300 400 500 600 700 800 900 1000 1100
BOILER HORSEPOWER DEVELOPED



Intercrystalline cracking, or caustic metal embrittlement may occur in boilers when the three conditions of metal under stress, presence of leakage in seams or tube-ends, and chemical action between boiler water and stressed steel exist simultaneously.

Betz engineers make use of an Embrittlement Detector, in which the first two conditions are synthetically established to determine if the third condition exists and the boiler water is, in fact, embrittling. If found necessary, recommendations are then made for the prevention of cracking by inhibitive boiler water treatment.

The Betz Organization is devoted exclusively to consultation, research and supervision in the field of water conditioning... from plant design to plant operation. In the solution of any and all water problems, Betz renders a complete service.

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WAR NEWS FROM THE INDUSTRIAL FRONT

(Continued From Page 84)

battleship or aircraft carrier has a power plant of capacities of up to 150,000 kw. or sufficient to furnish the ordinary power needs of a city of half a million people. The turbines being built for the two-ocean navy and the merchant marine total approximately one-half of the present installed capacity of all the power plants in this country.

More important than the over-all figure for the country is what is being done to increase capacity in strategic defense areas. In the Tennessee Valley area where a large part of our total aluminum output is being produced and where the production of ferroalloys and phosphorus is important, the Tennessee Valley Authority was scheduled to increase its capacity 159,000 kw. in 1941, 437,000 kw. in 1942 and 149,000 kw. in 1943.

In the West, where enormous aluminum and magnesium plants are being built and where some of our largest airplane and shipbuilding plants are located, public and private power agencies together are adding to their capacity.

New units for the Bureau of Reclamation's Parker and Boulder dams were scheduled to bring in 195,000 kw. additional capacity in 1941, 142,500 in 1942, and 30,000 in 1943. The P. G. & E. System, serving central and southern California, planned for an increase of 84,000 kw. in 1941, 66,000 in 1942, and 219,000 in 1943.

Similar expansions have been planned for the industrial East and Middle West, with Public Service of New Jersey scheduling 50,000 kw. additional in 1942 and 150,000 in 1943; Philadelphia Electric, 259,000 in 1943; Detroit Edison, 75,000 each of 3 yr. beginning with 1941; American Gas & Electric, 360,000 new capacity in 1942; Commonwealth Edison of Chicago, 74,000 in 1941; 160,000 in 1942, and 143,000 in 1943.

Power rationing may also be in store for shortage areas, and if, in order to assure vital defense industries all the power they need, power for civilian uses will be curtailed. Power shortages are expected in several parts of the country in 1942 and again in 1943, and probably will recur in the Southeast, because increased capacity will be absorbed by increased defense loads such as Texas, Arkansas and Louisiana where new magnesium, aluminum, and explosives plants are being built.

When the Southeastern shortage developed consumption was cut by a blackout of all nonessential lighting, such as signs, show-windows, interior and exterior decorative lighting, and flood lights for all purposes, including night football games. More than 40 interconnected utility systems forming almost a solid block from Texas to Florida and from Illinois to Virginia to feed their surplus power into the six states where the shortage existed. A curtailment of power for all large commercial and industrial consumers not engaged in vital defense production also helped.

The result was successful in that the power pool brought into the shortage area more than 40,000,000 kw-hr. a week, some 15,000,000 more than came in under the previous voluntary arrangement. The blackout and voluntary curtailment of residences reduced consumption by only 7,000,000 kw-hr. a week.

The pattern used in the Southeast, with such adaptions as are necessary to meet changed local conditions, can be followed in general when shortages develop elsewhere or recur in the Southeast, it is expected.

Conservation Control

DESIGNED to save vital material, principally tools and tool steel, as well as to speed up production at a time when supervising and training personnel are at a premium, the Disston Conservation Control Plan has been worked out to aid the Government's "War on Waste."

It is based on special instruction or Conservation Control Cards which tell the worker how to handle a particular tool; how to use it efficiently, how to keep it from breaking, how to sharpen it, and how to make the work easier and better.

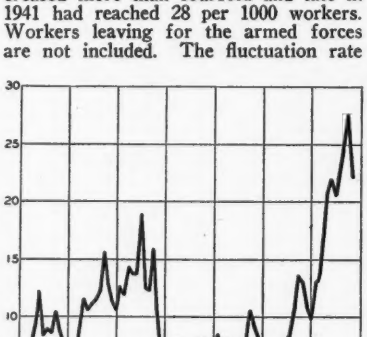
There are 35 of these cards covering cutting tools for metal, wood, plastics, etc., and including tool bits, files, hacksaw blades Carboloy knives and cutters, circular and band saws, planer knives, etc. These cards will be supplied without cost to industries upon application to Henry Disston & Sons, Inc., Philadelphia, Pa.

Cut Stacks to Save Aviators

LAWSON GENERAL HOSPITAL near Atlanta, Ga., is not far from Camp Gordon, the naval aviation training camp. To eliminate a serious hazard to the fledgling flyers, a new power house smokestack was built only 50 ft. high instead of the conventional 150 or 200 ft. The draft problem was solved easily by using an American Blower fan and hydraulic coupling with an Allis-Chalmers Super 7 V-belt drive. Lawson General is the basic military hospital for the Southeastern area.

Labor Turnover Increasing

DATA COMPILED by the Bureau of Labor Statistics indicates that the rate at which workers are voluntarily quitting their jobs is the highest on record. From early in 1940 the rate has increased more than fourfold and late in 1941 had reached 28 per 1000 workers. Workers leaving for the armed forces are not included. The fluctuation rate plotted by The Cleveland Trust Co. is shown in the diagram.



Voluntary quits among factory workers (expressed in number of persons per 1000 employed) is rapidly mounting

This rate of 28 per 1000 if continued for a year would mean the loss of one-third of the working force, seriously curtail the output per worker, increase the unit cost and greatly intensify the problem of training new workers. The discharge rate is about 1/10 that of the quitting rate and is also increasing due to the large number of new workers employed but found unsatisfactory.

Lubrication of High-Speed Diesels

(Continued From Page 67)

sources or from other oils previously used, as well as to keep the engine clean during further operations—and only by keeping the engine clean and free from deposits can it be maintained in efficient operating condition with minimum maintenance cost.

Compounded Diesel Engine Lubricating Oils

Due to the way in which the compounding operates, it is used up gradually. It is therefore necessary to maintain reasonable drain periods. In general, manufacturer's recommendations in this respect should be followed.

Compounded oils all produce a more stable foam than that formed by straight mineral oils. They do not generate foam in any greater amount than uncompounded oils of the same viscosity, but the foam lasts longer and, therefore, it appears that compounded oils foam more.

One result of the detergent characteristics of compounded Diesel oils is that the drainings always appear dark or black. This is normal and should be expected, as one essential purpose of the compounding agents is to "keep the engine instead of the oil clean". Due to this characteristic, it is also possible to use such oil to good advantage for purging engines which have become very dirty from the use of other types of less stable oil. When doing this, suitable precautions must be observed to avoid possible difficulty from excess deposits that may find their way into the oil stream.

There is no simple method of laboratory analysis which will determine the value of compounding materials of the type described. The following remarks on this subject by H. C. Mougey of General Motors Corporation are of interest:

"Unfortunately, there are no standardized chemical laboratory tests by which we can predict the performance of oils under heavy-duty service . . . The final measure of quality always must remain 'performance in service'. However, it is possible to make engine tests under controlled conditions; and, from the results of these engine tests, very good predictions as to performance in the various kinds of service can be made."

In other words, service tests and results are the only criterion that can be used. Therefore, it is necessary for the operator to rely on the engine manufacturer and oil company for guidance in the selection and use of compounded Diesel engine lubricating oils.

In 6-day bicycle races, if riders come to grief—it's usually on the turns where speed and strain increase the danger. (I.N.S. photo)

Accidents lurk when power and speed crowd *PIPING TURNS* too!

Weld piping with TUBE-TURN fittings to prevent trouble at the crucial spots!

It takes strength and stamina to withstand the grueling pressure of a 6-day bike race, but that's nothing to the strain and stress imposed on many piping lines. The greatest concentration of pressure in pipe lines is placed on the turns—*wherever there is a change of flow direction.* Tube-Turn fittings are engineered for added protection *where the danger lies*—wherever elbows, returns, tees, reducers, laterals, nipples and flanges are used. You will find a type, size and weight of Tube-Turn fitting for *every* pipe welding need. Look for the Tube-Turn insignia welded on each fitting.

Write for Tube-Turn engineering data book and catalog.

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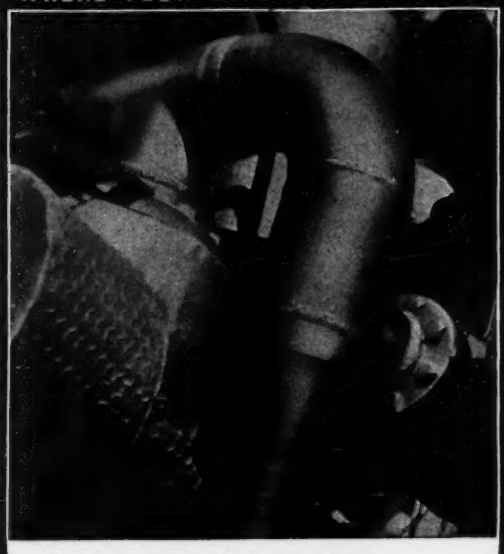
TUBE-TURN *Welding Fittings*
TRADE-MARK

HOW TUBE-TURN FITTINGS PROTECT WHERE FLOW DIRECTIONS CHANGE



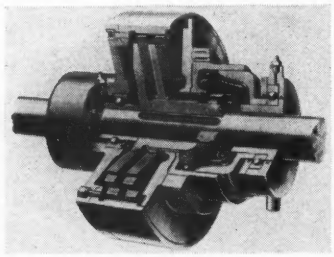
This compact piping installation illustrates four common points that occasion *changes in flow direction*—a welding tee at the top, then a 90° elbow, a reducing outlet welding tee at the right, and a concentric reducer near the bottom. Tube-Turn welding fittings are used here to guard against danger at these turns.

New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

Friction Clutch

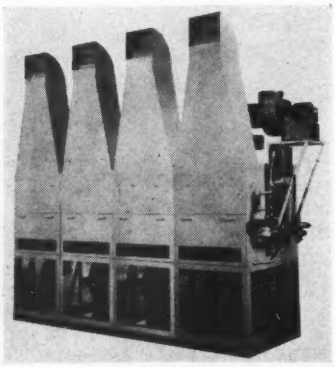
AVAILABLE in single and multiple disc types over a wide range of sizes, the Torque-Master clutch made by T. B.



Wood's Sons Co., Chambersburg, Pa., is designed for heavy work and high speed. As shown, friction plates have gear tooth drive, wear is compensated by one knurled adjusting ring and all parts are enclosed.

Unit Heater

A HEAVY DUTY unit heater has been added to the line of Janitrol gas-fired space heating equipment manufactured by Surface Combustion Corp., Toledo, Ohio. This new product is for the heating of large buildings and spaces that require delivery of air at high velocities, 1500 to 2500 f.p.m. Also, due to the low temperature of the incoming air, the heater must be able to raise the air temperature sufficiently to give a 100 to 125 deg. F. temperature rise.

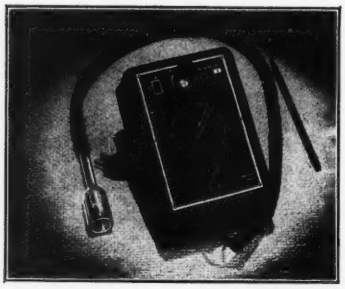


The new heater is known as the BBC-24 Janitrol series, and the design incorporates the Multi-Thermex heat exchanger and Amplifire burner.

The unit is built up of a series of sections, each section having an input rating of 250,000 B.t.u. per hr. Each section is complete, having its individual heat exchanger assembly, pilot, limit control and blower. The blowers of all the sections are mounted on a common shaft and driven by one motor. All sections are securely attached to a heavy channel iron base to insure ruggedness and alinement of the fan shaft.

Electronic Indicator

INDUSTRIAL INSTRUMENTS, INC., 156 Culver Ave., Jersey City, N. J., announces the successful application of the solu-bridge controller with a special conductivity cell, to the processing of mineral oil treated with concentrated sulphuric acid in large vats. At the end of the treatment cycle the concentrated sulphuric acid which has not entered into reaction settles to the bottom of the vat. Above this there is sludge with treated oil above the sludge.



The sulphuric acid is first drawn off from the bottom of the vat, followed by drawing off the sludge, and finally the treated oil. The conventional method of ascertaining when all the acid and sludge have been removed is by means of a by-pass pipe and visual observation. The operator at times does not notice when the withdrawal of sludge has ended and treated oil starts coming through.

By placing a special conductivity cell in the by-pass line, and setting the indicator of a solu-bridge controller, the self-contained relay of the instrument closes and actuates an alarm when sludge begins to come through. Again, with a different setting the relay will close and give indication when oil starts to come through. The conductivity cell placed in the by-pass line is of a special exceedingly rigid construction, utilizing one electrode, and designed particularly for these unusual conditions.

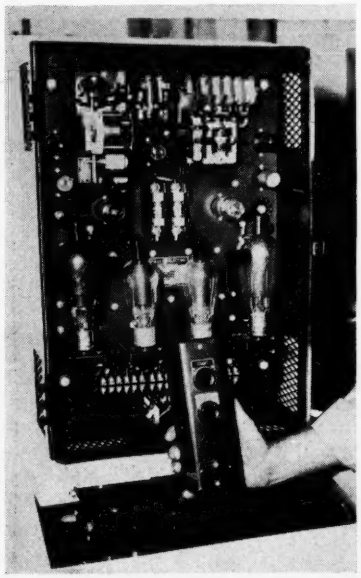
New G. E. Electronic Motor Control

AS AN OUTGROWTH of its thyratron speed control for d.c. motors, the General Electric Co., Schenectady, N. Y., has announced a new electronic control system, called Thy-mo-trol, to provide simple, stepless control of d.c. motors from a.c. lines wherever a wide speed range is needed.

With this new development, the flexibility of d.c. motors can now be combined with the economy and convenience of a.c. power distribution. The Thy-mo-trol system leads to simplified machine design, reduced space requirements, and a saving in time over more complex methods of obtaining a wide speed range.

Normally consisting of three separate units—a small control station, a transformer, and a thyratron tube panel —the control is the first to provide in one equipment the means for electronically starting, stopping, accelerating, and regulating the speed of a motor. Standard units will cover motor sizes up to 5-hp., 230 v.

The Thy-mo-trol system provides wide-range speed control without the use of motor-generator sets or gear and pulley arrangements. A single-dial control, mounted in a heavy-duty push-button station, covers the complete speed range of the motor, both above and below basic speed. The motor is automatically accelerated to preset speed quickly and smoothly without excessive current peaks. The same single dial can also be used to change speed to any desired value during operation.



Thy-mo-trol equipment can be provided for reversing service by the addition of a standard magnetic reversing switch. It can also be furnished with dynamic braking.

In operation, the change from alternating to direct current for the motor field and armature circuits is accomplished by two pairs of thyratron tubes. The control compensates for changes in armature-voltage-drop, holding mo-

"Keep 'em Flying"!

LUNKENHEIMER VALVES

Are Helping to Build Bombers

ESTABLISHED 1862
THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI, OHIO, U. S. A.
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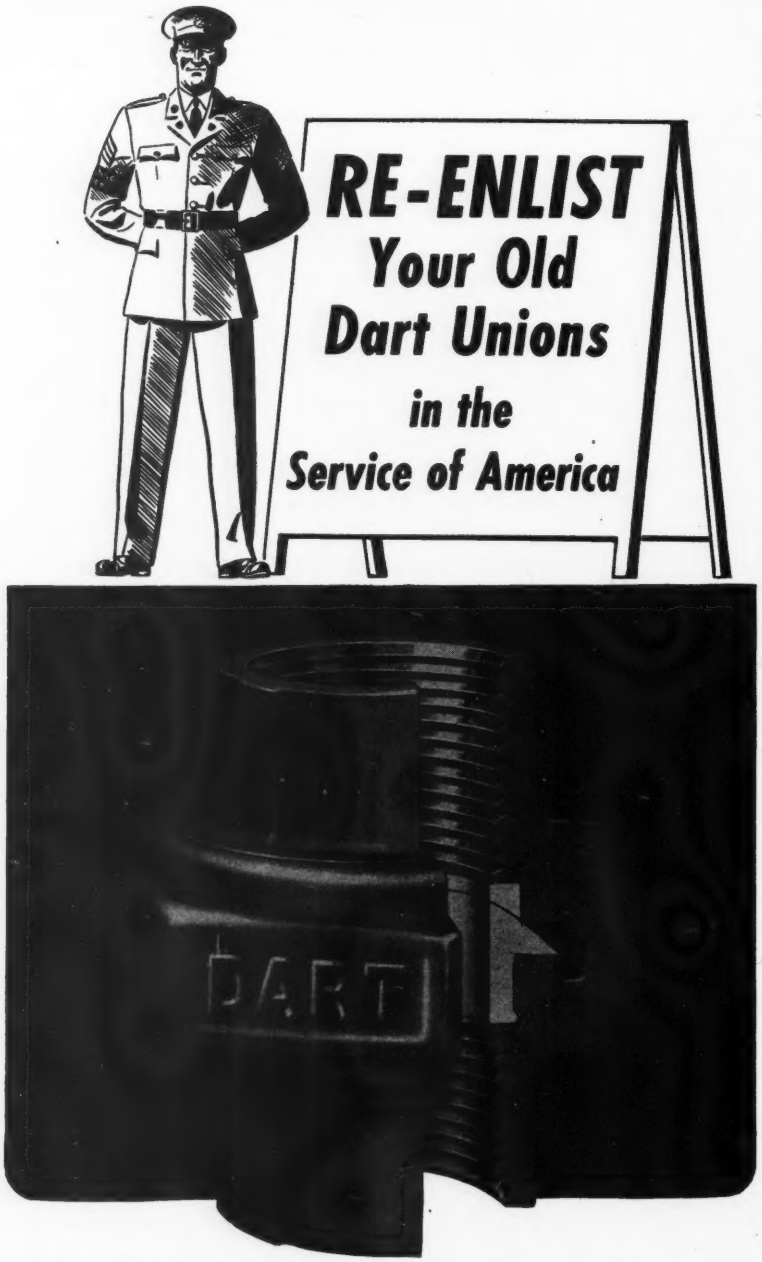
Your Lunkenheimer distributor has a supply. Ask for our [illegible]



Here is a patriotic tip, in behalf of metal conservation: Dart Unions, that have already given much efficient, trouble-free service and been "re-tired" or discarded, *are still capable of going back to active duty* . . . and of turning in a first-class performance. So, we suggest that a search be conducted throughout your plant to find and re-enlist your used Dart Unions in *your* particular Victory Effort.

There are excellent reasons why Dart Unions can be used so many times and give such complete satisfaction, such "first-time" tightness, every time. Here is one reason. Darts have matched bronze seats, ground to accurate "true-ball" surfaces. Here's *another*. Dart bodies and nuts are made of air refined malleable iron that resists pipe strains, rough handling, rust.

The manufacturers of Dart Unions are proud that old Darts as well as new ones are helping in this crisis. Remember—for *old* Darts search your plant and scrap piles of old pipe . . . for *new* Darts see your supplier today.

DART UNIONS

E. M. DART MFG. CO. Providence, R. I.

Sales Agents: The Fairbanks Company New York, and all branches
Canadian Factory: Dart Union Company, Ltd., Toronto, Canada

tor speed constant regardless of normal-load and line-voltage variations.

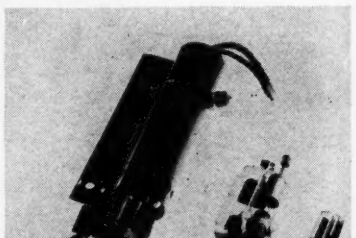
The stepless speed control increases armature voltage up to basic speed and weakens the field at speeds above basic. Acceleration is automatic. Full field is held until basic speed is reached and is also automatically applied during dynamic braking.

Thy-mo-trol equipment is compact and easily mounted. The control station may be located accessible to the operator, thus allowing complete control of a machine from one location. The thyratron tube panel can be furnished in various types of enclosing cases, such as those for corrosive or dusty atmospheres.

Three New Tubes

THREE NEW industrial electronic tubes, a thyratron, a kenotron, and a phototube sensitive to blue have been recently announced by the Vacuum Tube Section, Radio and Television Department, of the General Electric Co.

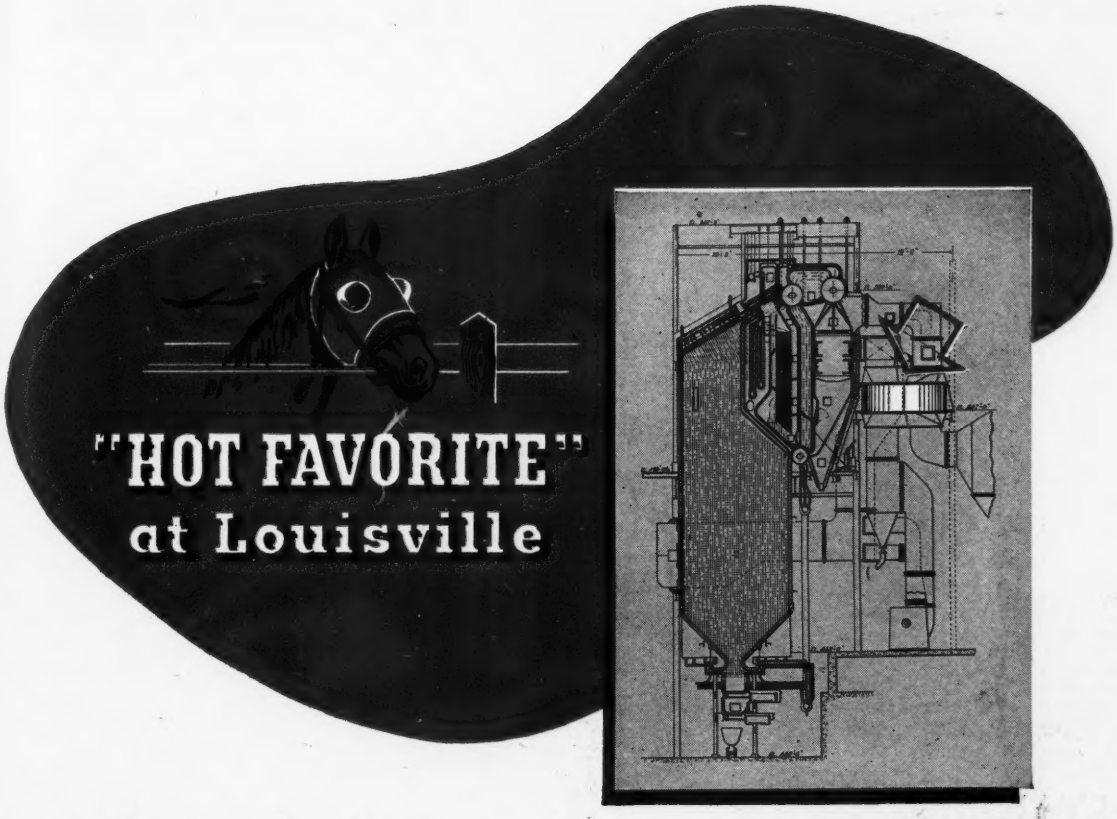
The newly designed GL-414 thyratron is an all-metal, negative-grid tube for general-purpose industrial applications. Since it has a shield grid, it is especially suitable for control circuits where the available grid power is very small, and where it is desirable to actuate the grid from a high-impedance source. Typical applications include use in motor controls, welding controls, power rectifiers, and in voltage regulators.



Featuring mechanical strength, ease of installation, and low voltage-drop characteristic of mercury-vapor tubes, the new thyratron has an indirectly-heated cathode rated at 5 v., 20 amp. Maximum peak inverse anode voltage is 2000 v., and average anode current is 12.5 amp.

The GL-451 kenotron is a half-wave rectifier, rated 30,000 v. peak inverse, 500 mil. amp. peak, 100 mil. amp. average. Its thoriated tungsten filament makes possible a higher rating for size than does a pure tungsten filament. Lightweight and a tantalum anode permit construction unaffected by ordinary vibration. This tube is designed to meet high-voltage, low-current requirements. It is especially suitable for use with smoke-precipitation and air-cleaning devices.

The GL-441 phototube is especially designed for a high response in the blue region of the spectrum, and has thirty times the quantum efficiency of red-sensitive tubes. Sensitivity is 45 microamp. per lumen at an anode voltage of 90.



Louisville Gas & Electric Company includes Ljungstrom Air Preheaters in its new steam generating plant . . . . . .

On this modern steam generating unit now ready to go into service at the Canal Station of the Louisville Gas & Electric Company — as well as on the two units under construction for the Paddy's Run Station — high heat recovery and efficient combustion have been pre-assured by the inclusion of a Ljungstrom Air Preheater. When the boiler is operating at its rated capacity of 312,500 lb. steam per hr., gases enter the preheater at 740° F., leave at 366° F., heating combustion air to 605° F.

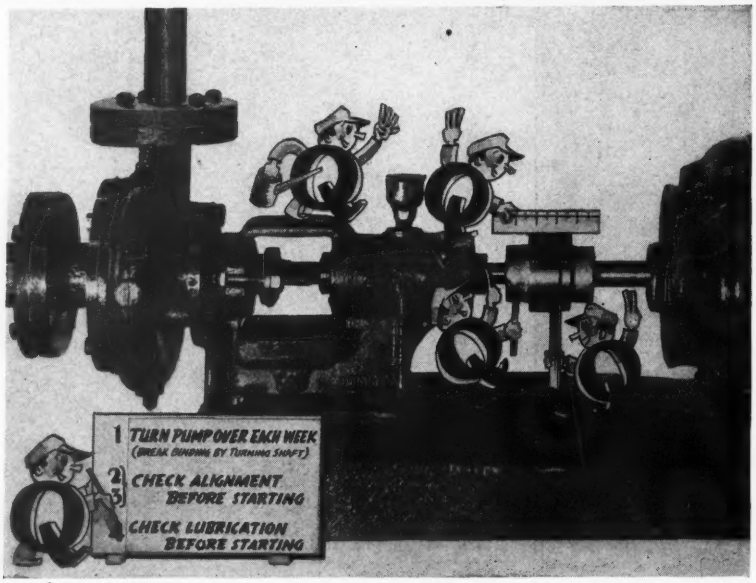
• • • • •

With peak loads the order of the day, it is more important now than ever before to maintain complete heat recovery along with availability for continuous service on the line. That's why experienced operators of steam generating equipment choose Ljungstrom Air Preheaters for use on high-efficiency units. They know the Ljungstrom is "tops" in thermal efficiency and mechanical dependability. Every leading boiler manufacturer has included them in outstanding installations made during the past year.

Straightforward engineering economics will demonstrate that the margin of advantage is definitely on the side of the Ljungstrom preheater in almost every case. If you'd like to see how the figures look for an actual installation comparable in size and operating conditions to the one you plan to build, write us today.

THE AIR PREHEATER CORPORATION

Executive Offices: 60 East 42nd St., New York, N. Y. **Plant: Wellsville, New York**


1 TURN PUMP OVER EACH WEEK
(BREAK BINDING BY TURNING SHAFT)
2 CHECK ALIGNMENT BEFORE STARTING
3 CHECK LUBRICATION BEFORE STARTING

★ STANDING IDLE ★

Pumps should not be allowed to stand idle for a long period of time. If service operation is not required they should be run for a few minutes at least once a week. If this is not possible they should be turned over by hand or bar.

If for any reason binding should occur from standing idle, turn the shaft slowly backwards for one complete revolution, rocking gently back and forth to start. If the pump is handling water and it stands idle for a long time there is a possibility of binding due to scale formation. Under no condition should power be applied after a prolonged shutdown without testing to make sure that the shaft turns easily by hand on the smaller sizes or by bar if it is a larger unit. If the pump has been out of service for any substantial length of time, the coupling should be checked for alignment, both angular and on centers. Also, before starting, after standing idle make sure that the suction line is tight, the suction valve open and the pump casing flooded.

CONCERNING DELIVERY: National defense priority may cause even our oldest customers some delay in delivery. We earnestly request your patient cooperation until our present expansion program can relieve this situation.

QUIMBY PUMP CO.
INC.
352 THOMAS STREET
NEWARK, N. J.

QUIMBY SCREW PUMPS

. . . GOOD PUMPING PRACTICE SINCE 1894 . . .

Precision Spot Welds

MAKING a spot weld is a precise process with several rigidly controlled steps. A typical resistance-welding cycle may last from 0.1 to 3 or 4 sec., depending on the kind and thickness of metal welded. The total time of a weld is further divided into the various intervals in which the welding machine goes through its operating sequence, and includes a "weld" period (3 to 30 cy.) when the full welding current flows.

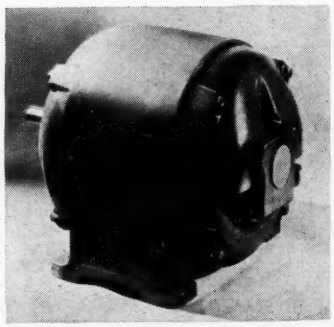
Sometimes, when welding thick plates or plates of brass or stainless steel the material is welded in several heating and cooling steps intermittently. A controller for this surface has an "overall weld" timing sequence, subdivided in several "heat" and "cool" steps, each ranging from 3 to 30 cy.

This timing is now done by a new controller developed by Westinghouse using plug-in telephone type relays for compactness, and thyratron tubes to actuate them. The operator, in order to establish the automatic timing sequence for the job at hand, simply places the plugs in the proper holes in the panel of the controller. The controls are mounted on hinged dead-front panels, which, for maintenance, can be swung open by removing a single bolt.

New Motor with All-Around Protection

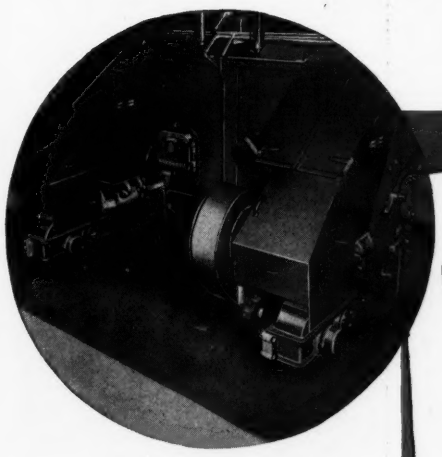
ALLIS-CHALMERS, Milwaukee, Wisc., describes the "Safety-Circle" protection of its new Lo-Maintenance motors as "the greatest motor improvement in years." Specially developed to give the motor complete all-around protection, the "Safety-Circle" is a wide, solid rib-integrally cast as part of the frame—which forms an unbroken circle of protection around the stator.

All the experience of building motors for over 50 yr. has been concentrated in the development of this advanced product. One-piece cast frame and cast end-shields guard the motor



from exterior knocks and abuse. A more liberal use of electrical materials makes this motor internally and electrically stronger because current and magnetic densities are less extreme. Improved bearing design delivers smoother performance with full-flow lubrication and easier maintenance. Additional cross strength has been built into the distortionless stator for maximum power efficiency. Rotor is keyed to the shaft for strength, and its outer surface is turned for smoothness and an accurate air-gap. Other Lo-Maintenance features are oil drains at bottom of bearings for easy flushing, removable end-brackets and large conduit box for handy wiring.

CANTON STOKER *Engineering saves 174 tons of coal..*



Above are shown two of the three Canton Stokers that are on the job saving coal (and money) for famous Grove Park Inn at Asheville, North Carolina.

After a careful survey of Grove Park Inn requirements was made by Canton Stoker Engineers, one Worm-feed and two Ram-feed units were installed. These Canton Stokers replaced firing equipment of another make. Immediately, coal consumption dropped from 492 tons to 318 tons—a 174-ton savings!

Perhaps the same money-saving opportunity exists in your steam plant. Our Engineers are offering timely suggestions to many vital industries, suggesting changes that increase capacity and efficiency and reduce fuel bills.

Your request for helpful literature or personal consultation will receive our prompt attention. Write, wire or phone today.

Below is shown cross-section of a Canton Stoker in operation showing method of feeding and burning coal.

GROVE PARK INN

above ASHEVILLE, N.C.

January 1st, 1940

Mr. N. S. Fulford
District Representative,
Canton Stoker Corporation
Canton, Ohio

Dear Sir:

We submit at your request the following data as to our fuel consumption during the months of October, November and December, following the installation of your stokers as compared with the same months as last year.

1937		1938	
Oct.	146 tons	Oct.	148 tons
Nov.	163 "	Nov.	144 "
Dec.	183 "	Dec.	163 "

1939	
Oct.	78 tons
Nov.	119 "
Dec.	121 "

The above figures are taken from the daily record and the reduction shown is attributed to various changes which we made in our heating plant. One of the most contributing factors, I believe to be, is the electric driven Canton Stokers installed. We have three of these stokers, one worm type, operating on our vertical 40 H.P. boiler, and two ram type operating respectively 2 H.R.T., 125 H.P. boilers.

The two ram type stokers are equipped with zone wind boxes and inside dump grates which adds much to our efficiency and greatly reduces the smoke and flyash problems.

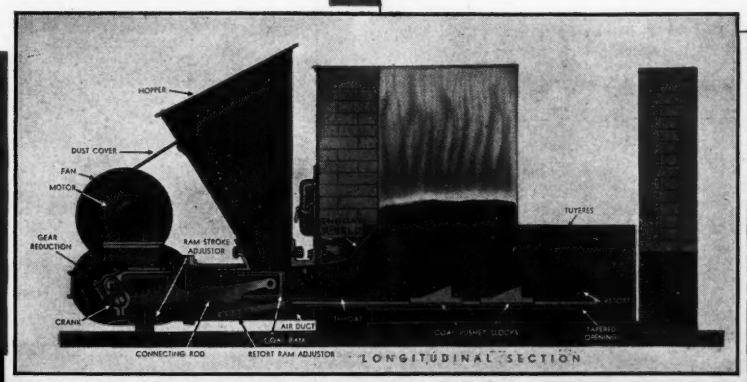
Yours very truly,

GROVE PARK INN

J. P. Roberts

J. P. Roberts
Engineer

JPR
IHB



CANTON STOKER

CANTON STOKER CORPORATION

ANDREW PLACE, S. W., CANTON, OHIO

Modern cleaners for modern boiler tubes

In modern boilers there are tubes everywhere, — floor tubes, roof tubes, side-wall tubes, screen tubes, baffle wall tubes, etc. These tubes are full of bends and curves (some on very short radius). Many are quite long (60 to 125 feet). Some are swedged down from one size to another. Several sizes of tubes are used in one boiler.

But modern boilers are like old timers in that the tubes must be cleaned occasionally. We furnish cleaners to the biggest central station plants and for the very latest types of boilers. If a tube is accessible so that a cleaner can be inserted, we can furnish the cleaner which will do the work.

Whether your boilers are up-to-the-minute or twenty-odd years old, Lagonda-Liberty cleaners have the proper types of motors and cutter heads, and the operating hose to do their work well and quickly.

Lagonda-Liberty cleaners are up-to-the-minute in design, and in the use of modern improved metals and heat treating methods. They do a quick and thorough job.

ELLIOTT COMPANY

Lagonda-Liberty Tube Cleaner Dept.

JEANNETTE, PA.

District Offices in Principal Cities

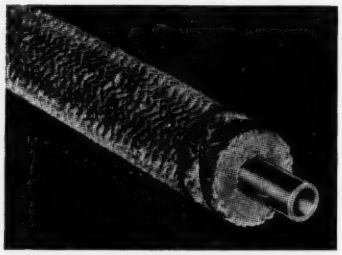
Y-164

LAGONDA LIBERTY TUBE CLEANERS

Tubular Insulation

PROBLEMS encountered in insulating small diameter heating lines on large airplanes have resulted in development of a new product known as "Insutube" by Union Asbestos & Rubber Co., Cicero, Ill. Light weight, small size, and ability to "stay put" under severe shock and vibration are listed as features which promise to have wide appeal for many industrial installations where small pipe or tubing is used to carry hot gases or liquids.

The material is made in the form of a seamless braided tube of long fibre asbestos with a wall thickness of ½ in., and is offered in a choice of sizes to fit pipes



of 1 in. and smaller. It is supplied either plain or with a water and grease repellant coating. In applying, the insulation is slipped on before assembly and is clamped at either end after being stretched tightly lengthwise on the pipe.

The insulation is ordinarily packaged in reels of 100 ft. length, but can be furnished in any desired length. The weight averages about 0.30 lb. per running foot in the ½ in. size. The standard grade is recommended for temperatures up to 500 deg. F., and special material can be supplied for higher temperatures.

Squeegee Pumps

HUBER PUMP DIV. of the Downington Mfg. Co., Downingtown, Pa., has recently developed an entirely new pump operating on the squeegee principle. It consists essentially of a flexible rubber hose which is alternately squeezed and released in a rocking, squeegee man-

ner and will handle either liquid or gas. The tube itself can be made of pure gum rubber or various acid and oil resisting synthetic materials.

Pumps are made in single and double stages with a range in capacity of from 1½ to 100 gal. per min. and also a special fractional g.p.m. unit made in one size with a capacity from practically zero up to 6 gal. per hr. It develops a lift of 25 ft. and a discharge pressure of 25 lb. It may be made in either plastic or bronze.

VICTORY PRODUCTION

The rugged character of R and PACO VALVES that you found to be a factor in the battle against high production costs now fights for you on the war front.

We are putting all we've got into the job and believe that a sincere all-out effort is the sure way to bring closer the day of Victory.

So it has become even more important that Reading-Pratt & Cady developed valves that will stand the drive of a 7-day production with minimum maintenance—and designed these valves with renewable features so that they can be continued in service at peak efficiency with the use of only minimum quantities of scarce and essential metals.

Reading Cast Steel Valves & Fittings, Pratt & Cady Brass & Iron Valves, D'Este Valve & Engineering Specialties

READING-PRATT & CADY
READING, PENNSYLVANIA

ACCO

A Division of AMERICAN CHAIN & CABLE COMPANY, INC. Bridgeport, Conn.

Temperature Indicator

TEMPILSTIK° is the trade name of a new form of temperature indicator recenlty announced by The Tempil Corp., New York, N. Y., which has a specified melting point. They are available from 125 to 1600 deg. F., in convenient temperature intervals and are reported to have a mean accuracy of within 1 per cent of the temperature clearly stamped on each stick.

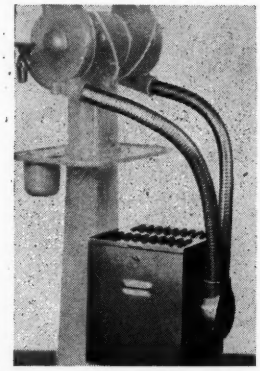
Thus a 300 Tempilstik°, drawn across a surface heated to less than 300 degree F., will leave a chalklike mark which melts sharply into a liquid streak when the surface reaches 300 deg. F.

Tempilstiks° provide a simple and convenient method of signalling desired preheating temperatures in the welding of steel, special alloys, cast iron and non-ferrous metals; in local heating, heat-treatment and fabrication of metals generally; in short, for all metal-working operations which require careful and accurate temperature control. They are particularly useful in the blackheat range, where the importance of accurate control is becoming increasingly recognized.

Self-Contained Dust Collector

LOW COST, unit-type dust collectors having a 600 c.f.m. rating and designed to exhaust pedestal, bench and surface grinders, cut-off machines, etc., is a new addition to the line of Aget-Detroit Mfg. Co., Detroit, Mich. The new model, known as Dustkop 600, and equipped with a ¼ hp., 3450 r.p.m., 110 v. a.c. single phase motor to provide a water-lift of approximately 3.3 in., is sufficiently compact to be mounted on a grinder, or on the floor behind the machine.

When connected with a tool grinder as shown, a two-way intake flange is supplied and a 2-in. flexible rubber hose completes the connection between the unit and the wheel hoods. When employed to serve only one wheel, an intake flange to accommodate a 5 in. pipe elbow is supplied.

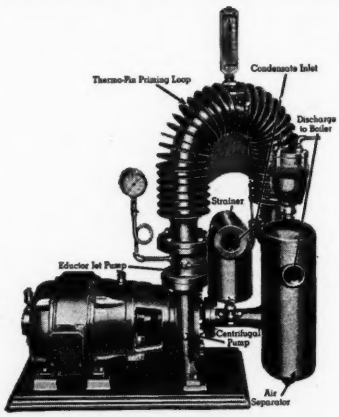


Removal of the collected dust and dirt is by lifting the louvered cover, taking out the filter assembly and lifting the pan, into which the dust has fallen after being stopped by the filter. Filters are of the spun glass variety, are said to stop over 99 per cent of the dust and are quickly renewable at low cost. Construction and design of the Dustkop is such that it will not support combustion, it is said.

Complete unit including motor, fan, filter unit, plug-in electrical cord connection and intake flange for either two-way or single 5 in. connection (but not including hose itself) lists at $82.50 F.O.B. Adrian, Mich.

H. P. Condensate Return System

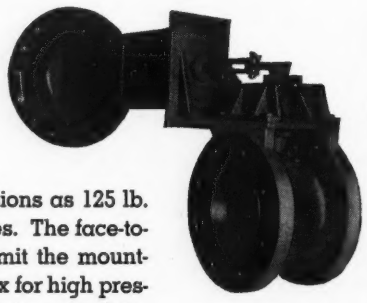
THE ESSENTIAL engineering features of the Cochrane-Becker high-pressure condensate return system, as announced by Cochrane Corporation, Philadelphia, Pa., are that its eductor principle of operation insures thorough condensate and air removal from process apparatus making increased production possible by maintenance of uniformly high temperatures. Then, after expulsion of the air from the closed circuit, the condensate is returned to the boiler at temperatures close to that of process



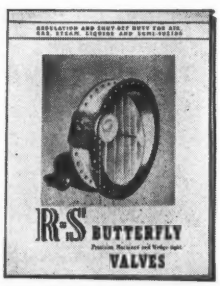
A Substitute for Steel!
Used in R-S Butterfly Valves

A remarkable new heat-resisting iron is now available for R-S Butterfly Valves. It has 42,000 p.s.i. tensile at 800° F. Stress relieved at 1200° F. to prevent distortion. Resists the penetration of gases and steam up to 1000° F.; non-growing up to 1200° F. More readily procured and costs less than steel. Machines the same as gray iron. Details for the asking.

Manual or Automatic Control and Shut-Off at 150 Lbs. Working Pressure



Series 15, Class B American Standard Butterfly Valve for heavy duty service. Same dimensions as 125 lb. American Standard cast iron valves. The face-to-face dimension is sufficient to permit the mounting of ball bearings and stuffing box for high pressures. 1/16" raised face. Automatic control by means of air diaphragm motor, hydraulic cylinder or electric motor.



Performance Data . . .
Flow Charts . . .
Specifications . . .

R-S Butterfly Valves — precision machined and wedge-tight for the regulation and shut-off of air, gas, steam, liquids and semi-solids —are either manually or automatically controlled. Write on your firm's letterhead for Catalog No. 10-B, which contains new facts and figures, much of which is published for the first time.

R-S PRODUCTS CORPORATION
4535 Germantown Avenue, Philadelphia, Pa.

...We pay our men to help You!

OUR Refractory Engineers are on *our* payroll, but their work can show up in *your* production schedule. Every man has spent at least five years, and some as many as twenty-five years, studying the applications of super refactories, their proper selection and use. While he is not a Jack-of-all Trades he does have a wide background of practical experience in many fields where refractory materials are used. He brings to your refractory and furnace problems not only his own judgment and experience but also, in addition, the engineering skill, ceramic knowledge and manufacturing technique of the entire Carborundum organization, the oldest producer of electric furnace super refractories.

This service is important to you because it can help you find ways of increasing furnace output, reducing outages and increasing the life of your refractories. Why not call on us at once?

CARBORUNDUM REFRACTORY PRODUCTS

THE CARBORUNDUM COMPANY

REG. U. S. PAT. OFF.

Refractory Division, **PERTH AMBOY, N. J.**

District Sales Branches: Chicago, Philadelphia, Detroit, Cleveland, Boston, Pittsburgh. Distributors: McConnell Sales and Engineering Corporation, Birmingham, Ala.; Christy Firebrick Company, St. Louis, Mo.; Harrison & Company, Salt Lake City, Utah; Pacific Abrasive Supply Company, Los Angeles, San Francisco, Calif.; Denver Fire Clay Company, El Paso, Texas; Smith-Sharpe Company, Minneapolis, Minn.

(Carborundum is a registered trade-mark of and indicates manufacture by The Carborundum Company)

ROTO
TUBE CLEANERS

for Every Power Plant Requirement

★ AIR or STEAM DRIVEN CLEANERS for
Straight tubes in water-tube and fire-tube boilers.

★ AIR DRIVEN CLEANERS for
Curved tubes in boilers, furnace walls, superheaters, economizers, etc.
Small tubes in condensers, heat exchangers, etc.
Large pipes up to 12" I. D.

★ WATER DRIVEN CLEANERS for
Straight tubes in water-tube boilers.
Curved tubes in boilers, furnace walls, etc.
Small tubes in ammonia condensers, etc.

★ CUTTING HEADS, including swing-frame self-feeding types, 4 and 6-way drill heads, combination drill heads, pivot heads, expanding scrapers and brushes.

★ UNIVERSAL JOINTS especially built for tube cleaner service.

★ OPERATING HOSE especially wound to withstand twist.

WRITE FOR DETAILS

The ROTO Company, Newark, N.J.

BETTER SERVICE — SAFETY — SATISFACTION
FOR REPLACEMENTS ORDER

Mica Shields Protectors

PRECISION GAGE GLASSES and GAGE GLASS GASKETS THAT WILL NOT BLOW OUT

Standard Square Cut Gaskets High Pressure Non-hardening and Non-softening

GASKETS THAT WILL FIT EXACTLY

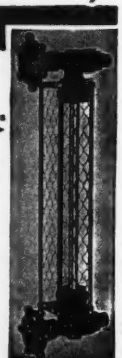
Red Lip-mold Pattern Expansion Type Gasket

Send for Glass and Gasket Chart

Shipment made by parcel post the same day as order is received

Send for Catalog E45

Wire Glass Guards



ERNST WATER COLUMN & GAGE CO.
RUBBER & GLASS DIVISION LIVINGSTON, NEW JERSEY

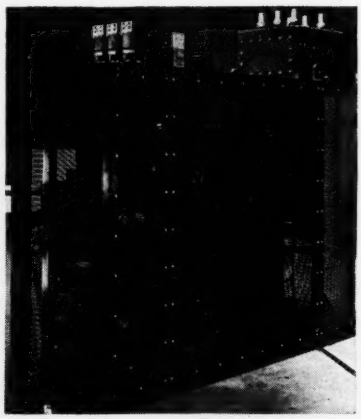
pressure without flash loss and with remarkable fuel savings.

The specially-designed centrifugal pump draws water from the thermo-fin priming loop and discharges it as a high velocity jet through the jet pump nozzle. This jet, striking the returned hot condensate, induces condensate flow through the mixing tube into the thermo-fin priming loop. The additional volume of the returned condensate introduced into the constantly filled loop results in the discharge of an equal volume through the air separator to the boiler.

The closed circuit from the boiler, through the process equipment and back to the boiler results in quicker and more uniform heating, this, it is said, increases production and improves quality. At the same time flash loss is eliminated providing 1 per cent fuel saving for each 11-deg. temperature gain.

New Unit for Secondary Networks

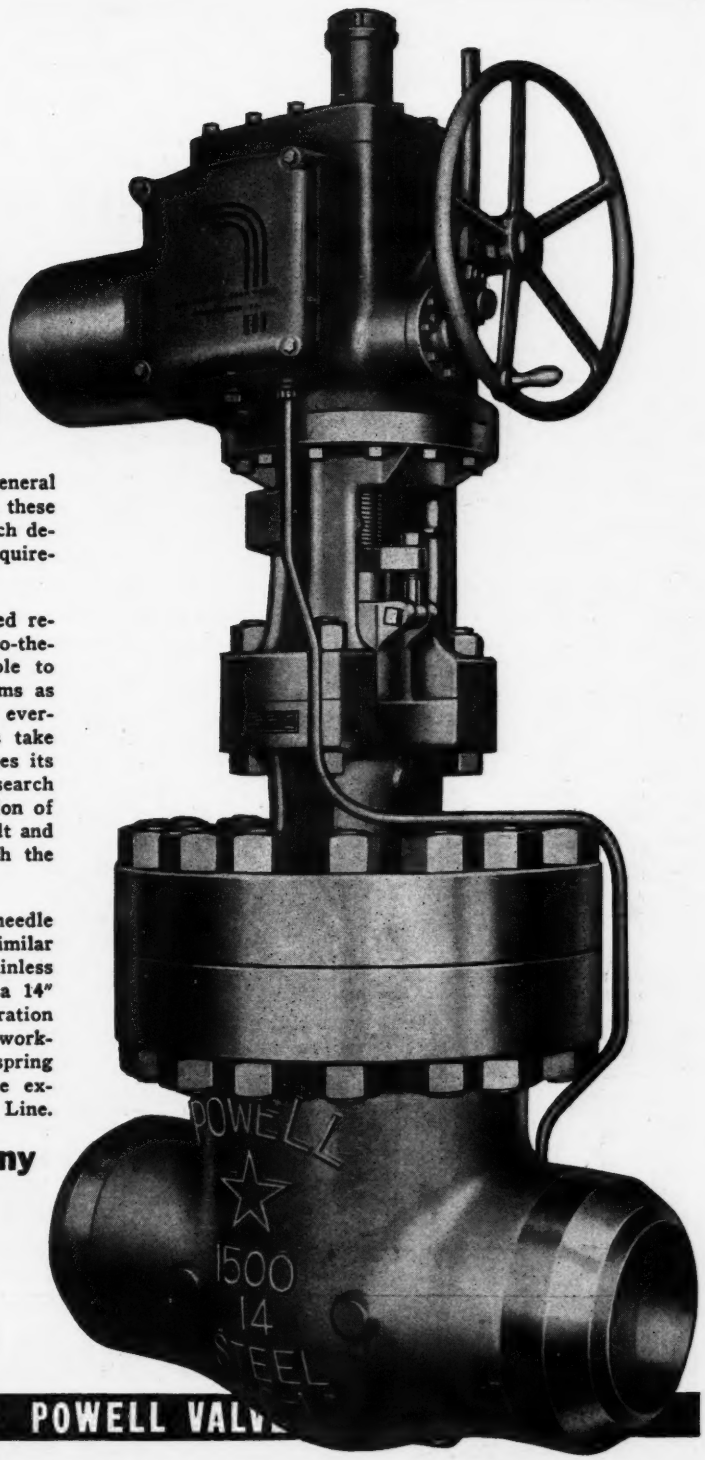
ESPECIALLY designed for industrial plants using secondary network systems, a new air-cooled network distribution unit is announced by Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa. Consisting of a high-voltage double-throw primary transfer switch, an air-cooled 3-ph. transformer and network protector housed as a single unit, the assembly transforms power from the primary voltage to secondary grid voltage. Ratings are from 300 to 1000 kv-a. on all standard voltages between 2300 and 13,800 with secondary voltages of 125/216 four-wire, 226/460 four- and 460 three-wire.



Primary air-break switch opens the exciting current of the associated transformer and will withstand a short-circuit current of 10,000 amp. for 2 sec. without damage to or appreciable movement of its parts. The 3-phase transformer is of the dry type, air-cooled and insulated with non-inflammable materials. High voltage windings are delta-connected with four 2½ per cent full capacity taps below normal; low voltage windings may be star or delta connected with no taps. Network protector is the 3-pole open type securely mounted in the low-voltage end of the unit housing and adequately spaced and barriered from all high-voltage circuits of the unit to permit inspection, test, and maintenance without danger of contacting high voltage portions.

(Continued on Page 130)

BETWEEN *these* EXTREMES

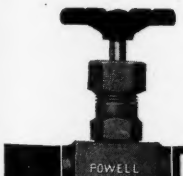


From the smallest to the largest valve in general use today the Powell Line extends. Between these extremes is a great assortment of valves, each designed and built to meet a certain special requirement of American industry.

Behind this line is a corps of highly trained research engineers with a vast array of up-to-the-minute laboratory equipment ready and able to work out the answers to new valve problems as they arise. These problems do arise with ever-increasing frequency as industrial advances take form. As each one is solved the answer takes its place in the Powell Line—and the Powell Research Engineering staff makes ready for the solution of the next one. Thus the Powell Line was built and thus it will continue to grow, in step with the inevitable progress of Industrial America.

The small valve shown is a ⅛" bar stock needle globe valve for instrument control and similar service. It is available in carbon steel, stainless steel and other alloys. The large valve is a 14" class 1500 lb. cast steel gate valve for operation on 920°F. steam at approximately 1500 lbs. working pressure. It is powered with Limitorque spring compensated motor operator. Between these extremes of size and design is the Powell Line.

The Wm. Powell Company
Cincinnati, Ohio



POWELL VALVES POWELL VALV

POWELL VALVES

2-WAY STEAM TRAP

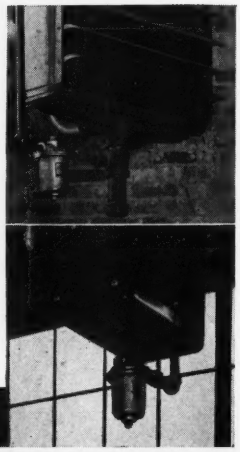
CONNECT IT STRAIGHT-IN-LINE OR AS AN ELBOW

You don't need two different traps to have a choice of connections—for Super-Silvertop is a "2-way steam trap" that connects either as an elbow *or* straight-in-line. If your drain pipe comes out of the bottom of a piece of equipment, use the elbow connection inlet at the top. If the drain is at the side of the equipment, use the side inlet of the trap and continue on in a straight line to the return line.

Then too, Anderson Super-Silvertops are designed with a solid gasket and all passages are drilled—avoiding the risk of steam leaks through a split gasket or the possibility of clogging or restricted flow that might occur with cored passages. Positive valve closing is assured by the guided bucket, and trap is easily inspected without disturbing pipe connections.

All these advantages are yours in a complete size and pressure range—from the small No. 19 up through the largest forged steel trap, so that every trap application gets full advantage of every Super-Silvertop feature.

Get all the facts about Anderson Super-Silvertop, the 2-way steam trap, the long-life, trouble-free steam trap. Send for your copy of the helpful book "How To Choose A Steam Trap."



THE V. D. ANDERSON COMPANY
1936 W. 96th Street • • Cleveland, Ohio

Super-Silvertop
STEAM TRAPS

Used Turbine Wanted

Wanted — Used Turbine in good condition for 140-lb. steam, 30-lb. exhaust pressure. 500 to 700 H.P., 3600 R.P.M. If driving a generating set, electrical characteristics should be suitable for 4150 volts or 220 volts 3 phase 60 cycle.

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NEWARK, N. J.
Attention: Engineering Dept.

Helpful Bulletins

BOILER PLANT EQUIPMENT

1 Stokers—Attractive 16-page catalog 1204, describes underfeed stokers, designed and developed for heavy-duty industrial boilers in both single- and double-retort type with stationary or moving grates and either electro-hydraulic or steam drive. Flynn and Emrich Co.

2 Oil Burners—New 4-page folder just off the press, describes a line of wide range mechanical atomizing oil burners employing the Peabody patented constant differential valve system. Advantages include — extremely wide capacity range; increased fineness of atomization over the entire range because of higher oil pressures; simplified control. Peabody Engineering Co.

3 Stoker—Helpful bulletin gives visual presentation of Iron Fireman spreader stoker, and includes in text matter: the company behind the product; the pneumatic spreader principle; feeding and conveying the coal; combustion in the furnace; and other brief articles. Iron Fireman Mfg. Co.

4 Stokers—Illustrated catalog describes Canton Lo-Set Ram Feed Stokers, used for smaller installations where space is limited. Typical installations pictured. Canton Stoker Co.

5 Stacks—Well illustrated 12-page catalog No. 109 covers various types of Thermix stack installations, including dust-collector stacks, recirculator stacks and fans, Multicyclones, and others. Prat-Daniel Corp.

6 Rotor Stoker—Bulletin 832 gives complete pictorial description of Detroit Roto Stokers applicable to all types of boilers. Successfully handles all fuels including semi-anthracite, coke, breeze, low, medium and high volatile bituminous, sub-bituminous and lignite. Many photographs and drawings of Roto Stoker installations in varied industrial plants are shown. Detroit Stoker Co.

7 Boiler Water Columns—New Catalog No. 45 pictures and describes the applications of Ernst adjustable water gages, water columns, try cocks, and safety guards. It shows how to avoid shutdowns by keeping boilers in service under all conditions. Ernst Water Column & Gage Co.

8 Stoker—New 8-page folder illustrates, points out advantages of and describes "Fyr-Feeder" stoker. Line drawings show essential parts, and principle of operation explained. It points the way to cheaper steam. American Coal Burner Co.

9 Integral Furnace Boiler — Fully illustrated bulletin G-34 gives complete data on integral-furnace boiler, either stoker firing or oil burning. Outstanding features of this unit are described in detail and cross sectional views show typical installations arranged for either stoker or oil firing. The Babcock & Wilcox Co.

10 Booklet on Draft — A 20-page booklet explains what draft is, the various kinds of draft, how it is measured, what the draft gauge tells, how to select the gauge for the particular requirement, where to measure draft and pressure in a modern steam plant, where to connect draft gauges on various types of fuel feed and how to actually install draft gauges under various conditions. Many charts and diagrams. The Hays Corp.

HELPFUL BULLETINS

Many useful engineering bulletins and catalogs are offered in the news and advertising pages of POWER PLANT ENGINEERING. For your convenience we publish the following summary of such literature mentioned in this and recent issues. To obtain copies of these bulletins and catalogs described simply indicate the paragraph numbers on the card below, detach and mail.

11 **Super Refractories**—Many charts on thermal conductivity and expansion of refractories and other helpful engineering data are included with descriptions of Carborundum refractories for heavy duty service given in a 76-page catalog. The Carborundum Co.

12 **Traveling Grate Stoker**—Attractively illustrated 28-page booklet covers unusual design characteristics of Riley-Harrington traveling grate stoker. Also includes performance data from seven varied installations. A valuable reference book for steam plant engineers. Riley Stoker Corp.

13 **Water Cooled Stoker** — Attractively illustrated bulletin describes the Taylor Water Cooled Stoker. Among advantages claimed are increased reliability, maximum fuel flexibility, higher operating efficiency. This bulletin, one of the first on the operation of water cooled stokers, has many diagrams, list of representative installations. American Engineering Co.

ELECTRICAL EQUIPMENT

14 **Power Factor Chart** — Bulletin GES-2765 gives a chart for determining power factor from line current, with and without Pyranol capacitors connected. Reverse side shows types of Pyranol capacitors. General Electric Co.

15 **Electric Heating Units**—Electric heating units and controls for industrial application involving the heating of liquids, solids or air are described in a recently revised 38-page catalog No. 28,000. Specifications, descriptions, ratings and prices of all types of heaters are covered, and 7 p. of application data included. Westinghouse Elec. & Mfg. Co.

16 **Circuit Breakers** — 4-page folder No. B6129 describes Types, DZ-60A, DZ-100A, and DZ-200A oil circuit-breakers, for 200 amp. or less, 15,000 volts, up to 500,000 kv-a. interrupting capacity. All parts of breaker shown separately, with brief description of each. Allis-Chalmers Mfg. Co.

17 **Power Distribution**—New 16-page, two-color booklet (GEA-3758) explains basic principles of load-center power distribution for industrials, naval and military projects, shipyards, central stations, and commercial buildings. It lists the chief advantages of the system; illustrates the available circuit arrangements; describes the necessary equipment for such a system as manufactured by G.E.; and depicts typical installations of load-center unit substations—all this in highly interesting, easily understandable form. General Electric Co.

18 **Transformers** — Booklet B-2304 answers questions about advantages, safety features, design, size and weight, maintenance and application of air-cooled transformers for factories, mines, and central stations. Westinghouse Elec. & Mfg. Co.

19 **Rotary Switch**—Rotary type instrument, control, transfer and auxiliary switches are described, illustrated and various combinations listed in a new 16-page catalog. Instrument switches include ammeter, voltmeter, frequency meter, wattmeter, temperature indicator, power factor meter and synchronizing switches. Diagrams of connections and switch developments are shown for each switch listed. Roller-Smith Co.

20 **Vibration Resistant Relay** — Described in a new bulletin is the Series 165 relay designed specifically for applications having a serious vibration problem, such as generator mountings, aircraft, etc. This relay passed a vibration test of 16.2 times gravity without making contact when the coil was de-energized, or breaking contact with coil energized. Guardian Electric Co.

21 **Fluorescent Lighting** — The new catalog of lamps and equipment provides a complete story on the design of a system of fluorescent illumination. Over thirty types of luminaires are described. A valuable guide for engineers with industrial lighting problems. Hygrade Sylvania Corp.

FANS, PUMPS AND COMPRESSORS

22 **Centrifugal Compressor**—New 20-page catalog No. 458, describes the latest designs in large-volume, high-pressure centrifugal compressors. Also included is information on application, methods of drive, lubrication and control, together with a discussion of the factors involved in effecting power economies, wide range of volumes at constant pressure, and quiet operation with minimum maintenance cost. B. F. Sturtevant Co.

23 **Air Pumps**—A new loose-leaf edition of the Gast Rotary Air Pump and Compressor catalog has recently been issued which contains concise data on the company's augmented line designed to meet especially the needs of defense production, including the new Gast V-Belt driven air pump. Illustrations and detailed descriptions of the various models are given, also specifications, engineering data and performance tables for 10 sizes, ½ to 23 c.f.m., vacuum to 28 in. and pressures up to 30 lb. Gast Mfg. Co.

24 **Pumps and Compressors**—A new 16-page Bulletin C-5 describes various types of rotary compressors, with details of construction and typical installations. Attractively illustrated, the catalog also describes single and 2-stage vacuum pumps. Fuller Company.

25 **Compressors** — Bulletin No. 192, 24 pages, describes horizontal, duplex, double-acting, water-cooled air or gas compressors for either single or 2-stage compression, with photographs and diagrams. Also outlines new control method. Pennsylvania Pump & Compressor Co.

26 **Screw Pumps**—8-page bulletin No. S-203 describes and illustrates Quimby screw pumps in three types: gear-in-head, external gear, and hopper. Test results of one pump included and photographs of several typical installations presented. A valuable book for engineers with pump problems. Quimby Pump Co.

27 **Pumps** — Two 6-page bulletins 228-1 and 229-1 on 2-stage volute centrifugal pumps, include specifications, sectional views, ratings, tables, dimensions, etc., to aid in selecting proper pumps for every job. Warren Steam Pump Co.

28 **Sewage Pumps**—Bulletin 206-2 is a 4-page illustrated treatise on non-clogging sewage and sludge pumps. Uses include handling of unscreened sewage and also sludge in industrial and chemical plants where it is necessary to pump liquids containing

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various solid and fibrous material in suspension. Lawrence Machine and Pump Corp.

29 **Ejectors**—A new 32-page Bulletin G-7 on Steam Jet Ejectors contains a complete and well illustrated discussion of ejectors including the theory and operation of both single-stage and multi-stage ejectors; characteristics, selection and application; and curves of air and water vapor mixture data and a pressure-temperature conversion table. The Elliott Co.

INSTRUMENTS AND CONTROLS

30 **Combustion Control**—Bulletin No. 91-41 is an installation report on Combustion Control, Water Level Control, Boiler Instruments as installed at Northern Paper Mills, Green Bay, Wis. Detailed data on how new 650 lb. power plant raised steam generating efficiency 25 per cent. Republic Flow Meters Co.

31 **Instruments**—20-page Bulletin R 40 features Ranarex instruments for measuring CO_2 in flue gases, specific gravity of gases, quality of furnace atmospheres, engine exhaust composition and special uses. Also shows some typical charts, scales and instruments. Permutit Co.

32 **Feedwater Control**—Bulletin 431, "Operating Experience at Ruppert Brewery with the Copes Flowmatic Regulator," is an 8-page article in which J. G. Morrow, assistant plant superintendent for Jacob Ruppert, describes the brewery's modernized boiler plant, with particular reference to the unusually close boiler water level control being obtained. Northern Equipment Co.

33 **Combustion Control** — Bulletin DR-39, 8 pages, contains explanations of combustion principles and functions of automatic control; descriptions and layouts of typical modern control installations for boilers using all types of fuels; and list of representative applications of company's equipment. A useful handbook for all steam plant engineers. Hagan Corp.

34 **Water Gauges** — Recent 4-page bulletin 741 presents water gauges in "PBH" vertical, tiltview and round-flange marine types with illustrations and descriptions of each type. Contains descriptions and illustrations of "PBH" water gauge specialties. Paul B. Huyette Co., Inc.

35 **Motor Control** — Attractive 36-page booklet describes Unitrol, method of grouping motor controls efficiently and compactly. Explains what Unitrol is, what it is used for, various arrangements available, and ease of installation. Samples specification for Unitrol sectionalized control center presented. Cutler-Hammer, Inc.

36 **Flow Meters**—52-page handbook shows complete line of flow-measuring instruments, including electric flow meters, electric linameters, mechanical flow meters, liquid-level meters, etc. Also gives applications to steam, air, water, gas, and viscous, volatile, and corrosive-fluid measurement. Cochrane Corp.

MECHANICAL TRANSMISSION

37 **Bearings** — Timely book shows what steps have been taken by company to meet defense emergency, importance of Timken bearings and steel in machinery used for making defense equipment, and necessity for Timken products in defense machinery. Timken Roller Bearing Co.

38 **V-Belts**—Attractive 8-page bulletin. B-6190, entitled "More Power to You" presents the points of difference in the latest Texrope V-belt, explains how Super-7 provides longer life and greater efficiencies because of 20% more and 50% stronger cords, new cushion rubber zone and duplex-sealed cover. Allis-Chalmers Mfg. Co.

39 **V-Belt Drives** — Ninety-six page catalog "Guide to Efficient V-belt Practice" offers a complete drive service on V-belts and sheaves, including pulleys for V-to-flat drives with all data conveniently arranged and indexed. Both multiple and fractional hp. drives are fully covered in this complete new guide. L. H. Gilmer Co.

PIPING, VALVES AND FITTINGS

40 **Steam Trap Handbook**—Tables, charts, diagrams and rules for selecting traps, giving complete explanations, make the new 36-page Armstrong Steam Trap Book a handy reference volume for every engineer's library. Armstrong Machine Works.

41 **Valves**—New illustrated Catalog No. 10-B, 16 pages, features standard and special butterfly valves for the control and tight shut-off of air, gas, steam, liquids and semi-solids under high and sub-zero temperatures and varying pressures from 2 to 300 p.s.i. Contains performance characteristics under all conditions of service, manual and automatic control, specifications and flow charts. R-S Products Corp.

42 **Flexible Metal Hose**—Bendix Bulletin H-201 gives complete information about Eclipse Seamless Flexible Metal Hose. Widely used for handling alcohol, grease, hot liquids, oil, steam and other non-solids where flexing and vibration are encountered. Bendix Aviation Corp.

43 **Forged Steel Fittings** — Bulletin No. A-3 describes the complete line of W-S Forged Steel Fittings in both socket welded and screw end types. Its many charts and tables make this a helpful handbook for piping engineers. The Watson-Stillman Co.

44 **Steam Trap Handbook**—How do you size traps? An easy method, plus valuable information on the installation and maintenance of steam traps is given in Catalog 63. The Strong, Carlisle & Hammond Co.

45 **Steam Traps** — 20-page Catalog No. 941 describes four types of traps, industrial steam, expansion steam, weight operated and piston operated, with many diagrams, drawings, tables and photographs. Also lists many representative users. W. H. Nicholson & Co.

46 **Pipe Units**—Catalog No. 41 contains complete data on all approved types of construction on underground conduit systems for steam and hot-water lines, with special emphasis on Ric-Wil presealed insulated pipe units. Ric-Wil Co.

47 **Valves** — Useful 96-page spiral-bound catalog presents some of company's various types of automatic control valves, designed for steam and water service. Operating sequence, construction, cushioning and arrangement of types listed. Golden-Anderson Valve Specialty Co.

48 **Steam Traps**—The revised 16-page Yarway bulletin T-1736 which has recently been released covers the Yarway Impulse Steam Trap and gives complete information regarding construction features, operating principle, installation and operating suggestions, capacities, prices, weights and dimensions. A valuable handbook for engineers and maintenance men. Yarnall-Waring Co.

49 **Relief Valves**—Catalog 70 Bulletin 23, 8-page booklet, describes relief valve and duplex back-pressure valve and vacuum breaker operation, installation, dismantling and reassembling. Also gives list of parts for valves described as well as spring ranges for average conditions. Foster Engineering Co.

50 **Steam Hook-Ups** — Recently released is a new 42-page book of engineering data on selecting, sizing, and installing steam traps, temperature regulators, water mixing valves, and heating system specialties with 75 hookup sketches of correct steam piping for all types of industrial and heating equipment. Sarco Co., Inc.

51 **Valves**—Catalog F-8 includes general information, material specifications, pressure-temperature service ratings on screw-end gate valves, screw-end globe valves, screw-end angle valves, and screw-end check and angle-check valves. Also covers strainers, chainwheels, gage cocks, reflex and transparent gages, and flanged gate, globe, check and slide valves, etc. Henry Vogt Machine Co.

This card should be filled in completely in order to secure the literature you request. Please indicate only the bulletins you particularly desire.

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52 **Hose**—Valuable 34-page booklet illustrates and describes hose for use in industry. Includes section on packing, couplings, and provides engineering tables showing pipe sizes, materials affecting rubber, and properties of saturated steam. Hewitt Rubber Corp.

PRIME MOVERS

53 **Turbines**—Bulletin 1951 gives a detailed description of steam turbines with combined reduction gears. Included with illustrations are typical installations, special features and dimensions. A useful handbook for turbine engineers. Moore Steam Turbine Div., Worthington Pump & Machinery Corp.

54 **Diesel Operation**—Texaco's Diesel Operation Manual contains 96 pages of charts, diagrams, photographs and text. Also new section on special purpose Diesel lubricants and Diesel lubrication chart. The Texas Co.

55 **Engine-Compressor**—18-page bulletin S-550-B-19 shows with photographs and diagrams basic design and practical applications of engine-compressors in refineries, refrigeration plants, sewage works, etc. Worthington Pump & Machinery Corp.

56 **Diesels**—4-page folder gives features, advantages, and comparative operating costs of Sheppard Diesel-electric package power unit. R. H. Sheppard Co.

57 **Steam Engines**—Two recent bulletins, "Modern Steam Engines" and "½ cent per Kilowatt hour power cost" deal with the flexibility, sustained overload capacity and economy of Troy-Engberg steam engines. Troy Engine & Machine Co.

WATER TREATMENT

58 **Zeolite Softeners**—Zeolite Water Softening is the title of recently released 8-page Bulletin 112 dealing with problems and processes of water softening. Included with a complete description are illustrations of typical installations. The American Water Softener Co.

59 **Chemical Feeders** — Bulletin describes Manzel chemical feeders for automatic boiler feed water treatment. Installed on boiler pumps, they automatically feed a small amount of chemical into the line with each pump stroke. Easily adjustable to fit your exact requirements. Manzel Brothers Co.

60 **Boiler Water Treatment**—A useful handbook has been issued on types of boiler water encountered, methods of treatment for scale prevention, etc. Suggests how to get more work from boiler equipment. The Bird-Archer Co.

61 **Hot Process Softener**—New illustrated bulletin pictures and describes the Graver Hot Process Continuous Water Softener for use in power plants. This softener combines two important principles: Chemical action, Thermal action. Bulletin contains handy water softener plant questionnaire for study of operating conditions. Graver Tank & Mfg. Co.

(Continued on Page 128)

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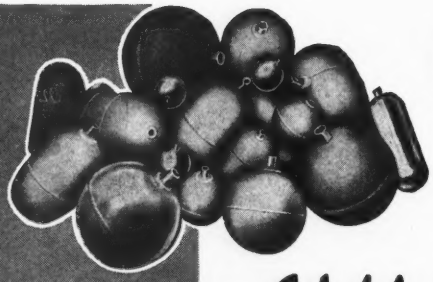

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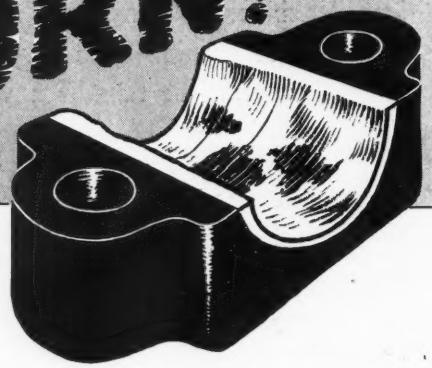

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MAGNOLIA BEARING METALS

62 Water Treatment—8-page bulletin entitled "The Solution to Your Problem" describes latest developments in proportioning and sampling equipment for water treatment. Well-illustrated with diagrams, installation photographs and tables. D. W. Haering & Co., Inc.

63 Water Purification — The SterOzone method of water purification without the use of chemicals is described in an informative eight-page bulletin that gives information on ozone as a purifier, its effectiveness in sterilization, the cost of ozone generation, and a flow sheet and specifications of a SterOzone water purifying plant. Technicraft Engineering Co.

64 Zeolite Softeners—Zeolite Water Softeners and other water conditioning equipment covered in the Elgin Bulletin 602. It describes a complete range of zeolite water softening equipment to meet every application. Included is the new Elgin "Double Check" Softener, with a new principle of controlling water distribution that increases softener capacity, prevents loss of zeolite, reduces backwashing, and cuts salt consumption. Elgin Softener Corp.

65 Stabilized Water — A stabilized water is one which does not precipitate scale forming calcium carbonate, but rather holds it in solution. Nalco Bulletin 28-S tells how stabilized water may be attained. Any engineer may obtain a copy free. National Aluminuate Corp.

66 Water Cooling Towers—Mechanical draft towers provide the efficient, adequate water cooling that enables plants to operate at "full speed ahead". Interesting data on installation and performance of Pritchard mechanical draft towers is given in Bulletin No. 42, just off the press. Bulletin No. 40-A describes atmospheric towers. J. F. Pritchard & Co.

MISCELLANEOUS

67 Unit Heaters — Helpful 16-page bulletin No. 454 covers Sturtevant downblast speed heaters, giving features, capacity tables, mounting-heights and floor-coverages. Installation diagram for two typical types of buildings shown. B. F. Sturtevant Co.

68 Building Maintenance — 74-page handbook has technical information for plant managers, maintenance men and superintendents. Shows how to do many odd jobs at lower cost with better results, and presents numerous ideas that save time and money. Non-technically written. Flexrock Co.

69 Packing Compound—New 4-page folder describes Colinite compound No. 3, for application to hydraulic plungers, rams, valve stems, etc., against acids, air, ammonia, steam, water, etc., to reduce friction and wear. Collins Packing Co.

70 Lubrication — Bulletin No. 7A, edition No. 5, describes Nugent pressure-liquid filters for acids, chemicals, oils, water, etc. Construction and operation of filter shown by diagrammatic sketches and photographs. Wm. W. Nugent & Co.

71 Packing Handbook—Just issued is the new Crane Packing Catalog No. 50, illustrating and describing its line of Metallic, Fabric, Plastic and Condenser packings. This handsome

edition of 96 pages covers the use of packings for equipment handling steam, water, air and gases, chemical, petroleum and refrigeration. Crane Packing Co.

72 Air Conditioning—28-page bulletin describes Carbondale equipment for buildings and institutions. Covered are air-conditioning units, refrigeration compressors, refrigeration condensers, deaerators, feedwater heaters, liquid meters, pumps, refrigerating units, room coolers, hot-process water softeners, etc. Carbondale Div., Worthington Pump & Machinery Corp.

73 Repair Handbook & Metal Protractor. A 40-page guide to the use of Smooth-On cements contains 170 diagrams and instructions for making lasting and economical repairs to plant equipment machinery, pipe lines, fixtures, etc. Free, useful protractor is also yours for the asking. Smooth-On Mfg. Co.

74 Industrial Lubrication—Newly issued bulletin describes Albany lubricants for industry; includes handy recommendation chart for lubricating compressors, conveyors, pumps, shafting, steam engines, turbines and other equipment. Albany Grease Co., Division of Adam Cook's Sons, Inc.

75 Power Plant Insurance—Helpful 8-page folder outlines coverage of policies written by company, and services available to policyholders. Comparative chart showing amount of policies written by competitive companies included. Hartford Steam Boiler Inspection and Insurance Co.

76 Spring Isolators—An 8-page Bulletin Ba-39, Extra Machine Hours, shows prominent installations of Korfund Type S Series Vibro-Isolators in a wide range of marine and stationary applications covering Diesel engines and general industrial machinery. A chart giving the rated capacities is included. The Korfund Co.

77 Electric Vibrators — Attractive folder shows typical installations of electric vibrators for keeping materials flowing freely through coal and ash hoppers, chutes, increasing weight contents, and eliminating air pockets. Syntron Co.

78 Non-Tilting Pump Valves—Non-tilting, steam saving pump valves for boiler feed, vacuum, condensate and general service pumps are fully described in 16-page booklet issued by Combination Pump Valve Co.

79 Heat Insulation Handbook—New 176-page Heat Insulation Handbook gives recommendations and practical pointers on the selection and application of various insulations for power plant operation. Contains many helpful tables, charts and graphs. A valuable handbook for engineers desiring to conserve heat. Ehret Magnesia Manufacturing Co.

80 Purifying Equipment — Keeping steam, vapor, gas and air lines clean means fewer shutdowns, increased plant efficiency. Illustrated Centrifix Bulletin tells about the application and advantages of internal steam purifiers, suction intake purifiers, exhaust line purifiers, compressed air cleaners, etc. A useful handbook for all maintenance engineers. Centrifix Corp.

"MEGGER"

TRADE MARK REGISTERED U.S. PAT. OFF.

Insulation Testers, Ground Testers and Ohmmeters

Today's Events

are emphasizing the importance and the dependability of these world-famous testing instruments, for detecting and preventing trouble in electrical equipment.

Do you have full information on how to operate and use them?

Write for . . . (no charge)—

Pocket Manual of "Megger" Practice.....No. 1420-PE
Technical Bulletin on Ground Testing.....No. 1285-PE
Ducter Ohmmeter (for quick measurements of very low resistance).....Bulletin 1635-PE

James G. Biddle Co.

1211-13 ARCH STREET *Electrical and Scientific Instruments* PHILADELPHIA, PA.

WE READ WATER

YOU TOO, CAN READ WATER

We have published a veritable water library—a fund of information on water treatment.

"Organic Methods of Scale & Corrosion Control," an authoritative 32-page treatise by David W. Haering, with 22 charts and photographs.

"Cooling Waters"—a 48-page booklet of articles on scale and corrosion in cooling systems.

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"The Solution of Your Proportioning Problem"—describes the popular Haering equipment for proportioning and sampling.

"Steam and Return System Control."

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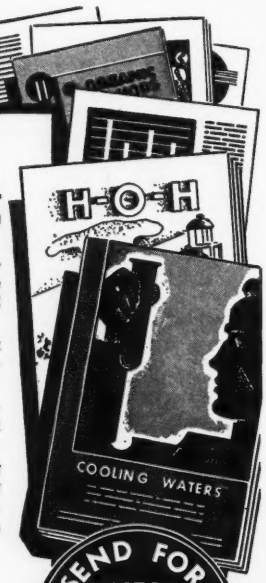
Write today for any of these and ten other booklets on water treatment for Power Plants, Refrigeration Plants, Petroleum Industry, Process Industries, Public Building and Transportation Industries.



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D. W. HAERING & CO., INC.
GENERAL OFFICES: 205 West Wacker Drive
CHICAGO, ILLINOIS

DE LAVAL-IMO OIL PUMPS
on Combustion Control

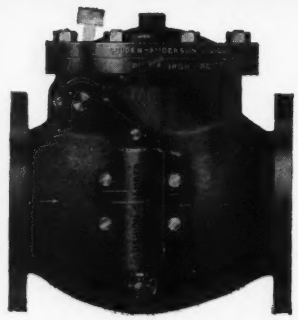
Hydraulic pressure oil to the combustion controls of the 2400 pound boilers in the Twin Branch Power Station of the Indiana & Michigan Electric Co. is supplied by these two De Laval-IMO oil pumps. This Station also has two other De Laval-IMOs for oil burner service, as well as De Laval centrifugal condensate, booster and hot well pumps.

Write for Publication I-89.

IMO PUMP DIVISION
of the
De Laval Steam Turbine Co.
Trenton, New Jersey

See page 66 of our new 96-page catalog for information on this

CUSHIONED SWING CHECK VALVE



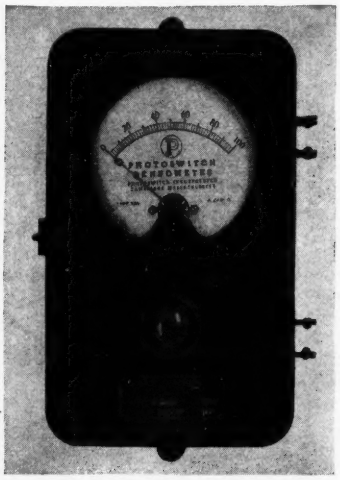
This Swing Check Valve is properly designed for balanced operation, and for allowing full pipe line flow with minimum pressure drop; and it is especially arranged with cushion chamber on the side to prevent any slapping or banging of the disc against the seat on reverse flow.

GOLDEN-ANDERSON VALVE SPECIALTY CO.
Fulton Building Pittsburgh, Pa.

An indicator recently announced by U-C Level Indicator Sales, Milwaukee, Wis., is designed to be screwed into the spigot opening of a liquid-containing drum and, in turn, to receive the screwed end of the spigot or faucet. So placed the indicator shows at all times the liquid level in the drum. Fits all standard 55-gal. steel drums.

Smoke Alarm

A NEW photoelectric smoke alarm, designated as Type A 25 C has been developed by Photoswitch Incorporated, Cambridge, Mass. The equipment includes photoelectric control, light source and an indicator.



The photoelectric control and light source are mounted on opposite sides of the flue or stack. The design of the lens system mounting minimizes the possibility of soot and dust gathering on the lenses. The control is wired to a Densometer which may be located at any point in the power plant for observation by the engineer. The Densometer gives a continuous indication of the smoke density. A small green signal light signals a clear stack while a large red bulls-eye indicates when excessive smoke is passing through the stack.

High Voltage Rectifiers

SLAYTER ELECTRONIC CORP., Newark, O., announces a new line of high voltage rectifiers designed to meet the requirements of both the production line and the laboratory. The rectifiers embody the results of several years of research and are said to provide a degree of compactness and flexibility not previously attained in high voltage rectifier equipment.

The electronic rectifiers are available in 20, 50, 100 and 200 kv. units, with a current range from microamperes to milliamperes. The entire unit is housed in a grounded metal case, with all the necessary metering devices built in as an integral part of the case. Small and light for the voltages produced, the units are readily portable, eliminating the need for a special chamber and permanent installation. The 100 kv., 1000 w. unit for instance, measures 3 by 3 by 6 ft., weighs 450 lb. with all controls, and can be moved with ease and safety.

10 REASONS why you can bank on FAIRBANKS

YOUR LOCAL FAIRBANKS VALVE DISTRIBUTOR IS READY TO SERVE YOU

Fairbanks has chosen its distributors carefully in order that users of Fairbanks Valves may be assured the best possible service at all times. These leading and representative easy-to-reach supply houses, by the very nature of their set-up, are industrially minded, appreciate the importance of selecting the right valves for different services and can be depended on to render every possible assistance promptly.

If you don't know the authorized Fairbanks distributor in your area, ask us for his name.

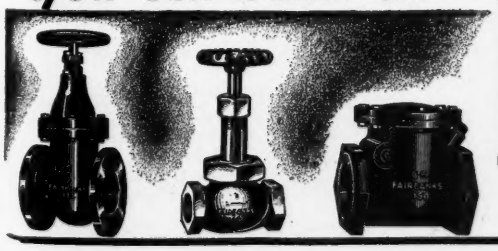
Fairbanks quality valves are backed by over 50 years of specialized experience. Specify "Fairbanks" on your next order. Write for catalog No. 21.

1. Prompt service through conveniently located distributors.
2. Standard and Renewable types for practically every need.
3. Quality in design, materials and workmanship.
4. Uninterrupted service.
5. Low in maintenance cost.
6. Maximum years of service assured.
7. Acclaimed for dependable performance.
8. Nationally accepted by users.
9. Backed by over 50 years' specialized experience.
10. Technical assistance in valve selection.

THE FAIRBANKS COMPANY

399 Lafayette St., New York, N. Y. Boston, Mass., Pittsburgh, Pa.
Factories: Binghamton, N. Y., Rome, Ga.

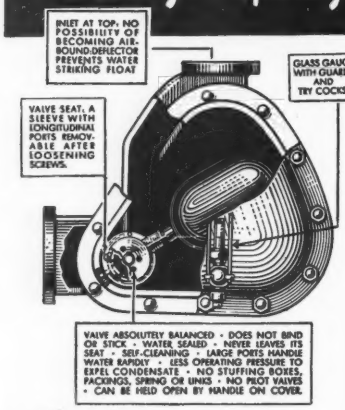
You can bank on...



FAIRBANKS

as the **RIGHT VALVES TO USE**

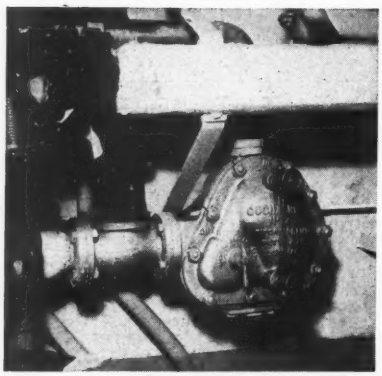
Extraordinary Discharge Capacity


INLET AT TOP. NO POSSIBILITY OF BECOMING AIR-BOUND. DEFLECTOR PREVENTS WATER STRIKING FLOAT
GLASS GAUGE WITH GUARDS AND TRY COCKS.
VALVE SEAT, A SLEEVE WITH LONGITUDINAL PORTS REMOVABLE AFTER LOOSENING SCREWS.
VALVE ABSOLUTELY BALANCED • DOES NOT BIND OR STICK • WATER SEALED • NEVER LEAVES ITS SEAT • SELF-CLEANING • LARGE PORTS HANDLE WATER RAPIDLY • LESS OPERATING PRESSURE TO EXPEL CONDENSATE • NO STUFFING BOXES, PACKINGS, SPRING OR LINKS • NO PILOT VALVES • CAN BE HELD OPEN BY HANDLE ON COVER.

Cochrane

MULTIPORT DRAINER

for *Quick* Drainage of *Large Quantities* of Condensate . . .



THE "Multiport" principle on which the Cochrane Drainer operates is that of a hollow cylindrical valve with a number of longitudinal ports which register with similar ports in the valve seat when the float is in the raised position. The combined capacities of these ports is unusually large, which accounts for the valve's extraordinary discharge capacity. For complete details mail this coupon.

COCHRANE

Cochrane Corp., 3123 N. 17th St., Phila., Pa.
Please send me copies of your publications on Condensate Drainage

Name.....

Firm.....

Address.....

City.....State.....

On all standard models the polarity of the unit can be reversed in a few minutes. The units can be turned on and used immediately, without waiting for "warm up," and can be operated continuously on full load. Units can

be supplied to provide substantially no "ripple" or large amounts of "ripple," depending upon the needs of the user.

MANUFACTURERS' NEWS

Sauerman Bros., Inc., Chicago, moved its general offices from 438 South Clinton St., to 522 South Clinton St., on December 15. The new quarters occupy an entire floor and provide enlarged facilities for all departments.

Bird-Archer Co. removed its New York office on February first from 90 West St. to 400 Madison Ave.

Borne Scrymser Co. has moved its executive and sales offices for lubricants from 17 Battery Place, New York City, to 632 South Front Street, Elizabeth, N. J., where office and plant activities will be consolidated.

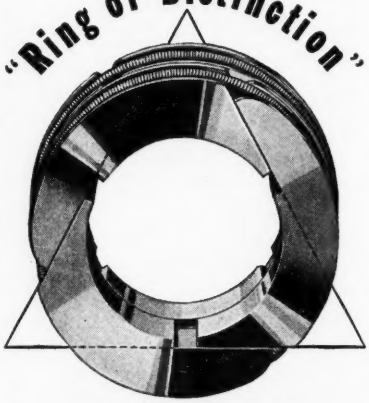
Widespread attention is being attracted by current delivery of the world's largest forging machines, one in November and the other in February to Tube-Turns, Inc., at Louisville, Kentucky, where they will be put to work in the production of airplane motor cylinder forgings and other armament needs included in the defense orders held by this company.

These are rated at 9 in. capacity, a feat of designing and construction viewed as impossible a few years ago. Each machine weighs over 500,000 lb., and requires well over a year to build, yet this unit occupies floor space sufficient to accommodate only four automobiles.

Harold M. Moore, St. Louis representative of Manning, Maxwell & Moore, Inc., for several years a Reserve Army Officer, has been called for active duty with the commission of a Captain with the 40th Infantry Division, Field Artillery.

FOR THE DEFENSE OF DEMOCRACY
THE BEST IS NONE TOO GOOD

FRANCE PACKING
has a
"Ring of Distinction"



Imitated but never duplicated, the France ring is manufactured in three sections. The contacting faces form the lines of an equilateral triangle. As the ring is expanded or contracted, the sections must move in or out radially equal distances from the center of the rod to which the ring is fitted.

This fundamental mechanical principle accounts for the efficiency, trouble-free performance and extra-long life of France Metal Packing.

After years of service, when the rings have become worn to such an extent that the sections nearly butt together, further years of additional service can be obtained by cutting off the narrow points of the three sections where they form a part of the inner circumference of the ring. The spring then requires adjustment so that the sections are held to the rod with a slight tension.

For installation in engines, pumps and compressors—under all conditions of service, France Full-floating Metal Packing means true economy in the long run.

ORIGINAL FRANCE METAL PACKING
Sold on approval
Satisfaction Guaranteed

Permit France Engineers to analyze your packing requirements. Write for Catalog M-5.

★

THE FRANCE PACKING COMPANY
Tacony, Philadelphia, Penna.
Branch Offices in Principal Cities

Original **FRANCE METAL PACKING**

Extra metal provides *Extra Value* in WeldELLS

BECAUSE the bursting stresses in an elbow are higher in the crotch* the wall must be somewhat heavier in this region if uniform strength is to be maintained. In WeldELLS this needed reinforcement is provided, thus assuring more nearly uniform stresses throughout the fitting.

This feature, based on soundest engineering considerations, is just one example of the *extra value* you get in WeldELLS — just one of eight good reasons for insisting on WeldELLS. And remember, please, that in spite of their premium quality WeldELLS and other Taylor Forge Welding Fittings cost no more.

TAYLOR FORGE & PIPE WORKS, General Office & Works: Chicago, P. O. Box 485
New York Office: 50 Church Street ● Philadelphia Office: Broad Street Station Bldg.

WeldELLS have *everything!*

No other fittings for pipe welding combine these eight features. In addition to that described here these features are:

1. **Seamless**—greater strength and uniformity.
2. **Tangents**—keep weld away from zone of highest stress—simplify lining up.
3. **Precision quarter-marked ends**—simplify layout and help insure accuracy.
4. **Permanent and complete identification marking**—saves time and eliminates errors in shop and field.
5. **Wall thickness never less than specification minimum**—assures full strength and long life.
6. **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
7. **The most complete line of Welding Fittings and Forged Steel Flanges in the World**—insures complete service and undivided responsibility.

*The amount by which stress is greater at the crotch in a fitting having uniform wall thickness depends only on its radius. Mathematical analysis (specifically the Lorenz formula) shows the stress at the crotch to be:

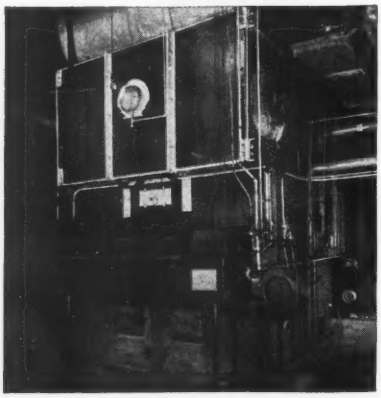
$$S = \frac{pr\,(2R - r)}{2t\,(R - r)}$$

Where S = Bursting stress, lbs. per sq. in.
p = Internal pressure, lbs. per sq. in.
r = ½ inside diameter of fitting (O.D. if Barlow's formula is desired).
t = Wall thickness in inches.
R = Center line radius of fitting, inches.

Numerous tests by the Research Division of Taylor Forge show the formula given above to be somewhat on the conservative side.

For Plants that Need

MORE POWER in a Hurry!



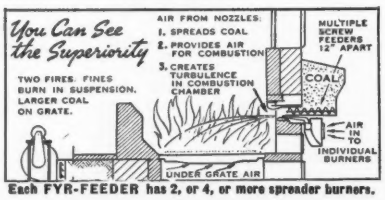
INDUSTRIAL PLANTS working on defense contracts, or otherwise able to obtain priority ratings, can get a quick, efficient solution for many of their power and steam shortage problems by writing or wiring American Coal Burner Co. *immediately.*

QUICK DELIVERY. Standardized construction features permit quick delivery of AMERICAN FYR-FEEDER spreader stokers to meet the requirements of virtually any size boiler plant, old or new.

HIGH OVERLOAD CAPACITY. FYR-FEEDER installations invariably provide ample excess capacity to enable plants to handle new peak loads.

MORE EFFICIENT USE OF METAL. There is no "dead weight" in a FYR-FEEDER stoker! Units are simple, compact, and require a minimum of special fittings, materials, etc.

CONSERVE FUEL. FYR-FEEDER stokers burn coal, wet or dry, with high efficiency. Hundreds of AMERICAN FYR-FEEDER units now in service are producing a high return on their investment.


You Can See the Superiority
AIR FROM NOZZLES:
1. SPREADS COAL
2. PROVIDES AIR FOR COMBUSTION
3. CREATES TURBULENCE IN COMBUSTION CHAMBER
MULTIPLE SCREW FEEDERS 12" APART
TWO FIRES. FINES BURN IN SUSPENSION. LARGER COAL ON GRATE.
COAL
AIR IN TO INDIVIDUAL BURNERS
UNDER GRATE AIR

Each FYR-FEEDER has 2, or 4, or more spreader burners.

AMERICAN FYR-FEEDER

SPREADER - STOKERS

AMERICAN COAL BURNER COMPANY, *ENGINEERS*
22-18 East Erie St., Chicago, Ill.
☐ YES, I want to know what the FYR-FEEDER can do in our plant.
☐ Please mail descriptive literature.
Name .....
Company .....
Address .....

James H. Withers has been engaged as a new representative working out of the Los Angeles office of Manning, Maxwell & Moore, Inc.

Announcement has been made by Union Iron Works of Erie, Pa., that the Engineering Sales Co., 1307 So. Michigan Ave., Chicago, Ill., has been appointed district sales representative to handle steam power plant equipment. H. E. Wheeler and H. J. Prebensen are the designated salesmen.

Appointment of George P. Passmore as Works Manager in charge of manufacturing of its Wellsville works has been recently announced by Worthington Pump & Mach. Corp. Until recently, Mr. Passmore has been manager of manufacturing of the South Philadelphia works of the Westinghouse Elec. & Mfg. Co.

Walter Geist, vice president of Allis-Chalmers Mfg. Co., was elected a director of York Ice Mach. Corp. at a meeting of the board of directors of the corporation held at York, Pa., in December.

Mr. Geist was born in Milwaukee in 1894 and entered the employ of Allis-Chalmers in 1909. After a rapid advance in many positions he became a designing engineer and researcher in the principle of multiple V-belt power transmission which he developed into the Texrope Drive. From assistant manager of the milling department, Mr. Geist became general representative in charge of the company's domestic and foreign offices, and in 1939 was elecetd vice president of Allis-Chalmers.

At a meeting of the board of directors of Allis-Chalmers Manufacturing Company held in Milwaukee, in January, Max W. Babb, president of the company, was elected chairman of the board of directors, and, W. C. Buchanan, a director and member of the executive committee, was elected to succeed him as company president. Mr. Buchanan has for the past 6 yr. devoted a substantial portion of his time to the Globe Steel Tube Co. in Milwaukee, of which he is president, and in which capacity he will continue.

Mr. Babb in becoming chairman of the board will fill the position formerly occupied by the late Gen. Otto H. Falk, which has been vacant since his death in 1940. In announcing the changes, the Allis-Chalmers board of directors said an effort was being made to improve the company's production to meet "heavy and increasing demands on its facilities in connection with war work."

Appointments of A. G. Jones as District Manager of the Pacific District Central Station-Transportation Department, and, of S. W. Scarfe as manager of the Los Angeles Central Station Department, have been announced by R. M. Alvord, commercial vice president of the General Electric Co.

Refractory Div. of The Carborundum Co., Perth Amboy, New Jersey, has recently appointed R. A. Barr as District Sales Manager in the Chicago territory. Mr. Barr formerly represented the company in the Cleveland District

SAUERMAN

Power Scrapers

STORING COAL —*at lowest cost*

At hundreds of power plants today Sauerman Power Drag Scrapers are storing and reclaiming coal at costs of a few cents per ton handled. This low cost is due to the rugged simplicity of the Sauerman equipment and its easy automatic operation. Aside from its economy, the most important fact about this system is that it piles the coal in well packed layers so that there is no opportunity for spontaneous combustion in the stored coal.

Write for Catalog.

SAUERMAN BROS., Inc.
586 S. Clinton St. Chicago, Ill.

How Advertising Speeds Progress

Besides raising our standards of living, good advertising greatly shortens the time between invention and utilization, which speeds the progress of new industries, helps make men and machinery more productive.

HOW TO KEEP PIPE LINES WORKING

...round the clock!

TIPS ON VALVE TRIM
TO HELP KEEP PIPING ON THE JOB
HELPFUL HINTS ON CHOOSING VALVES FOR BETTER PIPING SERVICE
HOW TO KEEP YOUR PLANT GOING WITHOUT INTERRUPTION!

These Bulletins Help Train Piping Crews; Aid in Getting Better Service From Valves and Fittings

VICTORY demands round the clock production! And while the burden will have its toll of plant equipment, industry's pipe lines—*its life lines*—must not fail in this task.

Keeping pipe lines working means getting better service from valves and fittings. That demands *more* and *better trained* men to keep up with and ahead of wear and tear. And that's where Crane Shop Bulletins are helping industry. These Bulletins, designed especially for maintenance workers, are full of practical pointers on installation and care of piping. They help train new men—improve the work of veterans as well.

The Bulletins are being widely used in maintenance shops and employee training schools. In the hands of your men, they will also help prevent piping trouble—*and keep production moving!*

Crane Shop Bulletins are offered to every plant—big and small—to help *speed* Victory. No charge—no obligation! For your supply, just call your local Crane Representative—or write to us.

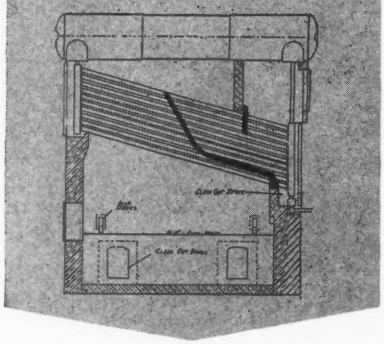
CRANE

CRANE CO., GENERAL OFFICES:
836 S. MICHIGAN AVENUE, CHICAGO

VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

NATION-WIDE SERVICE THROUGH BRANCHES AND WHOLESALERS IN ALL MARKETS

ANY type of boiler will deliver MORE POWER at LESS COST with Enco Streamlined BAFFLES

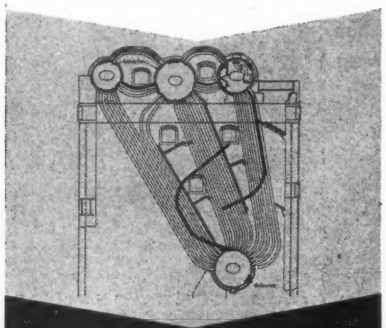


THE cross-flow principle of Enco Streamlined Baffles with its higher efficiencies, may be applied to any type of boiler—horizontal or vertical, straight or bent tube.

By streamlining and curving, gas passages are tapered to maintain velocity as the gas volume is reduced, resulting in a higher rate of heat transfer to boiler and superheater surfaces, and lower flue gas temperatures.

Enco Streamlined Baffles reduce draft loss by eliminating eddy currents, bottlenecks and dead gas pockets—save steam because soot blowers work less often and more effectively.

Ask for Bulletin BW-40 containing valuable engineering data on modern baffle wall construction—It's free.



THE ENGINEER CO.

Enco 75 West St. New York, N. Y.

and recently has been Sales Promotion Manager of the Division. He takes the position recently vacated by R. A. Beverly.

Frank H. Boyd, for 30 yr. Divisional Manager, Cleveland territory, American Seating Co., has been appointed Sales Manager of the S. G. Frantz Co., Inc., manufacturers of magnetic separators, New York City.

T. S. Knight, General Electric commercial vice president, has announced three appointments, in the New England District, effective as of January 1, 1942. R. W. Adams became assistant district manager, New England District; R. W. Herrick, manager of the Central Station Department, New England District; and D. E. Walch, manager of the Providence Office.

The International Nickel Co. has appointed three new assistants to J. F. McNamara, Monel Sales Manager. They are W. J. Calnan, H. D. Tietz, and E. A. Turner. H. E. Searle, formerly an assistant to Mr. McNamara as Manager, Engineering Sales, for the Monel Department, has been transferred to the Nickel Sales Department under R. L. Suhl, Sales Manager. C. J. Bianowicz becomes head of the Chemical Section of Monel Sales to succeed E. A. Turner.

G. J. Nicastro has recently been transferred to the New York District Sales Staff of Combustion Engineering Co. He joined the company in 1934 and has served in various capacities in the Proposition and Controller's Department.

Ralph J. Lundrigan has joined the Cochrane Corporation, Philadelphia, to supervise the merchandising of the new Cochrane-Becker high-pressure condensate return system.

The New York office of W. H. & L. D. Betz, Chemical Engineers and Consultants, is now under the direction of V. W. Hooper. R. H. Hayman has been advanced to the position of Assistant District Manager of the Betz offices and laboratories in Chicago. A. B. Baner, a chemical engineer of long experience, has been assigned to the New England territory. Howard E. Jordan is replacing Mr. Baner in the North Jersey territory. R. C. Wardlow, chemical engineer, has been placed in charge of sales correspondence in the Philadelphia office. W. P. Woodward, chemical engineer, has recently been transferred from the Detroit, Michigan, territory to the Wichita, Kansas, territory.

Recent personnel changes in and additions to the staff of D. W. Haering & Co., Chicago, Ill., include the promotion of H. C. Daggett, formerly eastern division manager, to the position of general sales manager; appointment of Nat Bailey, formerly chief chemist of Waukegan Coke & Chem. Co., as research chemist in Chicago and addition of Tom Palen and Jarvis Johnson, chemists in the Chicago Service Laboratory: Dr. Dyer B. Lake has been placed in charge of the New York Service Laboratory; F. H. Wright has been promoted to manager of the Chicago Winchester Ave. Unit and O. R.

Help Wanted

GRADUATE mechanical engineers with several years' experience engineering and design, all mechanical phases steam electric stations. Write giving full particulars age, education, experience, salary expected. Employment New York City. Box No. 1224, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

YOUNG graduate mechanical engineers, one or two years out of college; good opportunity learn all phases engineering and design, steam power stations, heat balances, etc. Write giving full particulars age, education, salary expected, previous experience, if any. Employment New York City. Box No. 1225, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

WANTED—Power Plant Operators for operating pressures of 700 pounds or over. Illinois location. Replies held confidential. Please type. Photograph desired. Address Box 1223, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

Opportunities Offered

SALES ENGINEER FOR POWER PLANT EQUIPMENT. Preferably graduate chemical or mechanical engineer. Must have knowledge of chemistry as applied to water conditioning. Travelling part of time, Minnesota and vicinity. Deferred classification in draft. Give complete particulars and salary desired in application. Address Box 1226, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

Buy With Confidence

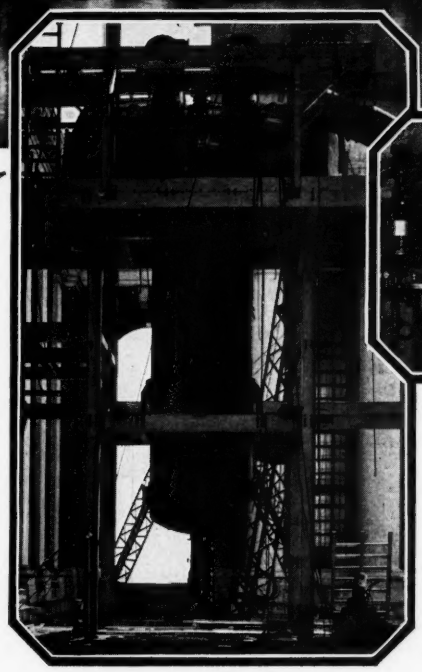
Manufacturers of boilers, stokers, turbines, engines, pumps, piping, belting, motors and other equipment, who continue to advertise, must have products which have proved their worth by useful service. You can place full confidence in them and depend on them to deliver utmost value.

If you read the advertisements of such concerns, which are found regularly in POWER PLANT ENGINEERING, and study their messages, you can be confident of buying trustworthy power plant machinery and equipment from these progressive advertisers.

Water Conditioning at Chester STATION

PHILADELPHIA ELECTRIC COMPANY

Each of the Cochrane CARBITE Softeners (above) is equipped with a 3-inch single control valve. Note salt-storage and brine-measuring tanks in foreground.



The Cochrane Steam Sample Degasifier (center) separates non-condensable gases from the boiler steam for further gasometric analysis.

The specially designed Cochrane Deaerator measures 8 ft. in diameter and can deliver 1,310,000 lb. per hour of "zero-oxygen" water. Deaerator is shown in place during erection of station's new addition.

THE Cochrane Deaerator at Philadelphia Electric's Chester Station supplies "zero-oxygen" water to the high-pressure boilers for the new #5 and #6 turbines. The 25-ft.-high Deaerator storage tank is specially designed for variable pressure, operating in parallel with the existing constant pressure units. Variable water level in the Deaerator storage tank compensates for the changing Deaerator pressure and maintains proper head on the pumps supplying the high-pressure boilers through closed heaters and supplying low-pressure boilers at the same time.

Makeup to evaporators is supplied through a double-unit Cochrane CARBITE Zeolite Softener equipped with rotary-disc single control valves. Separate salt-storage and brine-measuring tanks are employed. Chester City water with 4 to 8 grains of hardness per gallon is treated by exchanging the hardness ions for sodium in the CARBITE beds. The two 5½-ft.-diameter softening units are each capable of softening 65,000 gallons of 8 grain water between regenerations.

COCHRANE CORPORATION • 3123 N. 17th ST. • PHILADELPHIA, PA.

COCHRANE PRODUCTION DIRECTLY FOR DEFENSE

Deaerators for U.S. Navy and U.S. Maritime Commission Ships . . . by Cochrane Corporation, long-time specialists in the conditioning of boiler feedwater. One of a growing list of power-plant equipments developed primarily for National Defense . . .

Cochrane

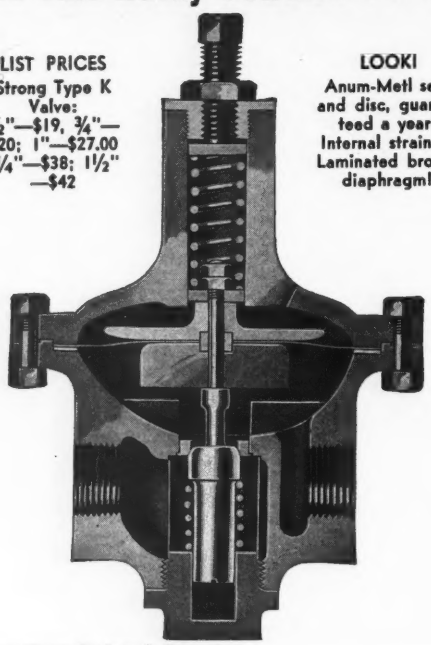
SOFTENERS • DEAERATORS • FLOW METERS • STEAM SPECIALTIES

PIPEWRENCH PETE SAYS:

Here's A Medium Priced Reducing Valve That Works!

Single Seat and Disc, No Packing In This Husky STRONG Valve

LIST PRICES
Strong Type K Valve:
½"—$19, ¾"—$20; 1"—$27.00
1¼"—$38; 1½"—$42



LOOK!
Anum-Metl seat and disc, guaranteed a year! Internal strainer! Laminated bronze diaphragm!

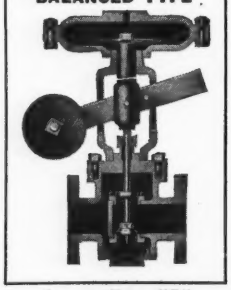
Name Your Reduced Pressure From 0 to 85 Pounds!

Here's the answer to accurate low-cost pressure reduction! Strong's Type "K" Reducing Valve, with its Anum-Metl seat, internal strainer, and simple, self-contained mechanism is ideal for reducing power steam to pressures you can use for heaters, cookers, driers, etc.

Adjusting spring holds valve open until reduced pressure reaches point desired. Outlet pressure then raises diaphragm against action of spring, closing valve, and completing cycle.

Write about your pressure reducing problems or for Catalog 154-PE-11.

BALANCED TYPE



Strong Type "B" For inlet pressure to 125 lbs., giving reduced pressure from 30 lbs. to 5 lbs. below atmosphere.

The Strong, Carlisle & Hammond Co.
1392 West Third St., Cleveland, O.

STRONG
STEAM SPECIALTIES

Borngesser placed in charge of the Wichita Service Laboratory; D. R. Walser has been promoted to Chicago district managership, C. E. Erb to Wichita, Kansas, district manager and E. H. Snyder to Houston, Tex., district manager. George Perry has been appointed west coast manager and P. A. Dobson is now in charge of Los Angeles, Cal., territory and Joseph Paulson is in charge of Portland, Ore., and surrounding area; G. Knight-Smith has been placed in Dallas, Tex.; E. M. Lloyd in Baltimore, Md., Walter Beschenbossel in Minneapolis, Minn., and R. C. Rohrdanz, superintendent of Shelley Refining Co., has returned to active service for Haering in the Houston, Tex., territory; Frank W. Mrazek has been placed in charge of New Orleans, La., and W. S. Nathan has been added to the Milwaukee, Wis., staff; C. French and G. Conrow have been added to the Chicago Service Staff; W. F. Renner of Red Springs, N. C., has been placed in charge of North Carolina operations.

M. E. Lord, manager of the Fort Wayne Works of the General Electric Co., announced that construction of a $25,000,000 factory at Fort Wayne, Ind., for the manufacture of turbo-superchargers for airplanes was started on December 2.

Expected to be finished by July 1, the building will be erected by Stone & Webster Engineering Corp. of Boston, Mass., as a Defense Plant Corp. project. It is to be one story high, 800 ft. long, 700 ft. wide, and have 560,000 sq. ft. of floor space. Approximately 4000 employes will be required at peak production. A factory for similar work has recently been completed at Everett, Mass.

Albert Bachofer, a 62-yr.-old machinist's idea for doing his job 40 per cent faster has earned him the largest award presented by Westinghouse for 2186 employe suggestions accepted in 1941 from employes at the East Pittsburgh Works. He has been awarded $750 for his time-saving suggestion. The number of accepted employe suggestions this year is 22 per cent ahead of last year, and the company has paid $15,998 in awards for these ideas, a 24 per cent increase of 1940. More than 84,000 suggestions have been submitted by employes since the introduction of the suggestion system in 1910. For each suggestion accepted by the committee of supervisors an award is given which is based on the first year's net saving resulting from the suggestion.

Obituaries

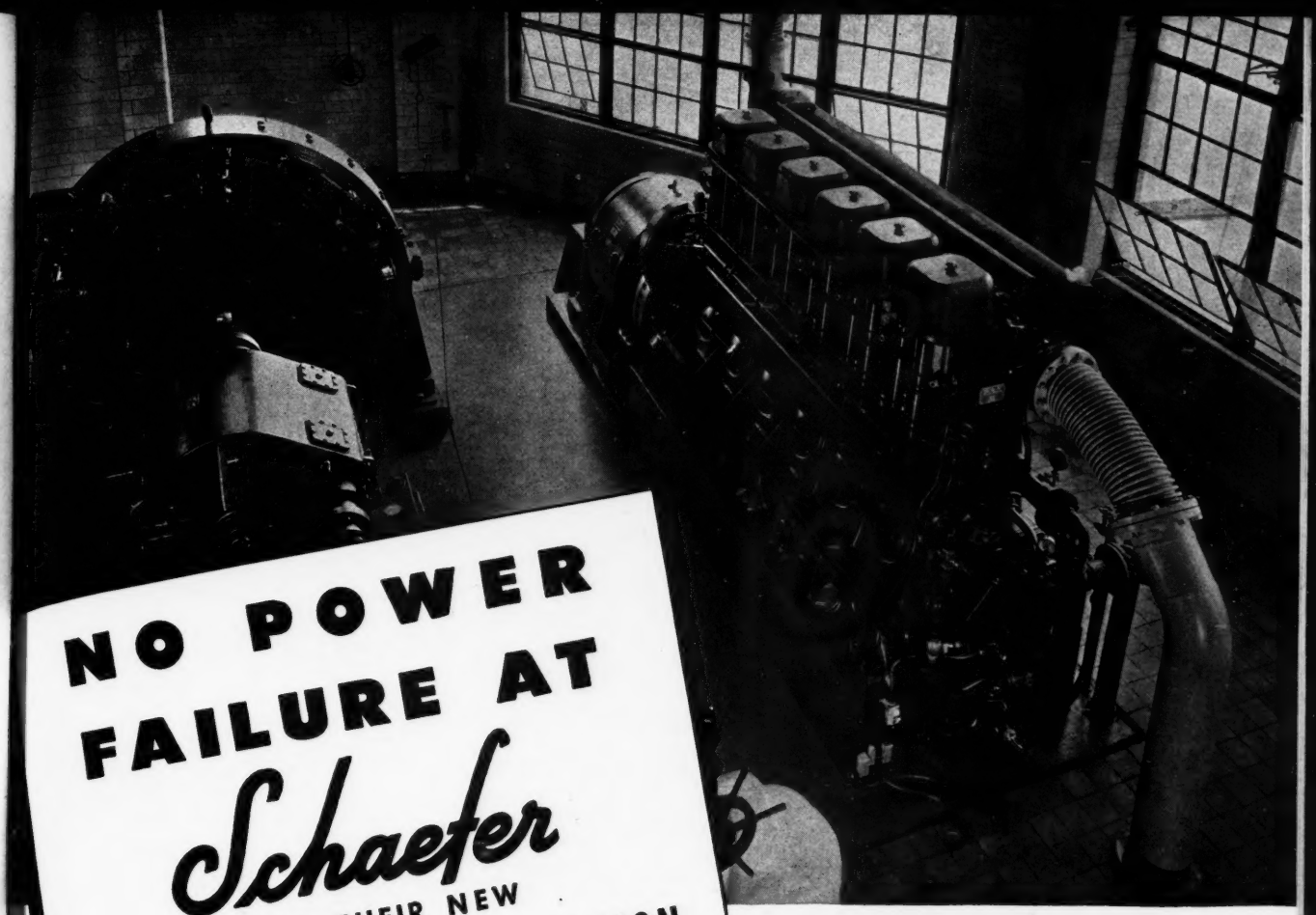
Dr. Frank Conrad

DR. FRANK CONRAD, assistant chief engineer of the Westinghouse Company, and widely known as the father of commercial radio broadcasting, died, unexpectedly December 10 of a heart attack, at the age of 67, in Miami, Fla. Born in Pittsburgh, Dr. Conrad joined the company in 1890, after completing the seventh grade. Seven years later he had given the world his first important contribution, the round type electric meter now in general use. He became interested in the time signals sent out by the Naval radio station at Arlington and developed a crude radio receiving set from which he advanced to his own sending set. His experiments led to the establishment of station KDKA, the world's pioneer broadcasting station. During the first world war he devised special airplane radio apparatus and improved existing hand grenade designs. Dr. Conrad obtained more than 200 patents in radio and electricity during his 51 yr. with the company and received many honorary degrees and medals for his scientific achievement.

A. B. Lawrence

A. B. LAWRENCE, associated with the General Electric Co. for 41 yr. and active in the switchgear field since 1902, died December 8. He was 62.

A native of Schenectady, N. Y., Mr. Lawrence was graduated from Union College in 1900, and immediately entered the G-E Test Course. In 1902 he was assigned to general office sales and proposals on switchboards, and was appointed assistant manager of switchgear sales in 1907. Ten years later, he became assistant to the manager of the Company's switchboard department, transferring to the old Baltimore Works in the same capacity in 1920. Following completion of the West Philadelphia Plant in 1929, he became section sales manager in the switchgear division of that plant. For the past 7 yr. he had been acting as supervisor of sales promotion and commercial engineering in the switchgear division at Philadelphia.



NO POWER FAILURE AT *Schaefer* WITH THEIR NEW DIESEL-STEAM COMBINATION

Power failure problems were eliminated at The F. & M. Schaefer Brewing Company's Brooklyn plant when this new 6-cyl., 600-hp De La Vergne diesel engine was recently installed alongside the steam turbine also shown. Thus the inherent dependability of diesels in the ultimate emergency is again exemplified.

"Two necessary services will be performed by the diesel," says Fred Ophuls, consultant and designer of the plant, "The first of these is to meet the demand for current for lighting and operation of small motors over weekends; the second is the ability to continue the racking and bottling of the beer, should some emergency force the steam plant to shut down. Our experience with the engine seems to indicate that we have been able to fulfill these requirements with the unit we have installed."

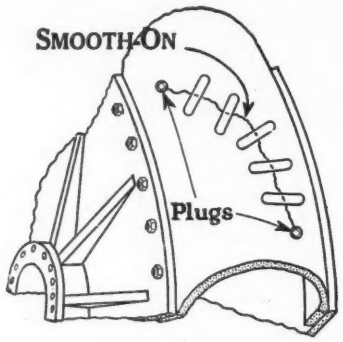
Your best assurance for an uninterrupted power supply is a De La Vergne diesel. Known throughout the country for their dependable and economical operation, De La Vergne diesels are available in sizes from 200 bhp to 1,500 bhp. Let De La Vergne engineers investigate your power problem.

Baldwin De La Vergne SALES CORP.

SUBSIDIARY OF THE BALDWIN LOCOMOTIVE WORKS
PHILADELPHIA

BLW THE BALDWIN GROUP

SPEEDY REPAIRS ... a lesson from the last war



Throughout the last World War, enthusiastic plant engineers wrote us that they had made speedy, lasting repairs to plant equipment and structures with SMOOTH-ON No. 1, thereby avoiding lengthy repair jobs that would have otherwise required much valuable time.

Profit by these experiences, and keep a can of SMOOTH-ON handy for the emergency that may arise at any time . . . perhaps just when a repair delay would hold up work on an important war order.

With SMOOTH-ON, you will be prepared to stop leaks in pipe lines, seams and joints, seal cracks in casings of pumps, valves, and process equipment, and tighten loose parts of machines and fixtures . . . without dismantling apparatus, and without using heat or special tools.

FREE **40-Page Handbook explains how**

Buy SMOOTH-ON in 7-oz., 1-lb., 5-lb. cans or larger kegs from your supply house, or if necessary from us. For your protection, insist on SMOOTH-ON, used by repair men since 1895. Obtainable from your dealer, or if necessary, from us.

This useful manual, illustrated with 170 diagrams, gives concise, simple suggestions that will save you time, labor and expense on repair and maintenance jobs all around the plant. A real necessity for every engineer, and will be sent you FREE if you fill in and return the coupon.

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Do it with **SMOOTH-ON**

NEWS FROM THE FIELD

George A. Bradley Retires at Lansing

GEORGE A. BRADLEY, for over 20 yr. the Chief of Plants for the municipal power and water system of the City of Lansing, Mich., retired from active duty January 1, 1942, due to age and failing health. Mr. Bradley has an enviable record of service with the city, having assumed his position in 1921 soon after the city had acquired the holdings of the Michigan Power Co. During his period of service he has been instrumental in the construction and operation of Moores Park Station and Ottawa Street Station, as well as extensive modernization and enlargement of the water production facilities of the municipal system. Prior to his employment by the city he held a responsible position with the Allis-Chalmers Mfg. Co., installing large machinery throughout the United States. He expects to continue to make his home in Lansing.

George A. Abbott, who succeeds Mr. Bradley as Chief of Plants, has been in the employ of the City of Lansing since 1923. Graduating as a Mechanical Engineer from the Michigan State College in 1928, he has had wide experience in both Station Operating Department and the Mechanical Engineering Department of the municipal system. Since the completion of Ottawa Street Station he has held the position of Plant Engineer in charge of that station.

Boston Edison Promotions

AT A MEETING of the directors of the Boston Edison Co. recently, presided over by President James V. Toner for the first time since his election, Dec. 5, to succeed the late Frank D. Comerford, the promotion of a number of officers of the company was made.

Vice-President Robert E. Dillon was elected a director to fill the vacancy caused by Mr. Comerford's death. Edward J. Hyland of Cambridge, a graduate of Boston University and Edison comptroller since 1938, was elected treasurer. Alfred C. McMenimen and John T. Ward were elected new vice-presidents.

The functions of the company's vice-presidents were designated as follows: Leavitt L. Edgar, merchandise sales and promotion; Mr. Dillon, production, distribution and engineering; Thomas H. Carens, public relations; Mr. McMenimen, taxes, reports and general accounting; Mr. Ward, power sales and technical research.

New Union Electric Officers

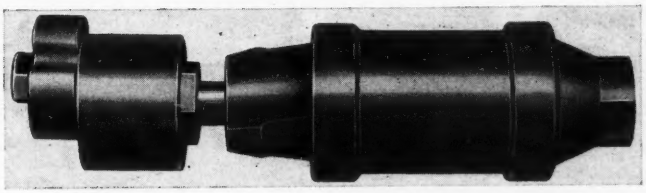
J. WESLEY MCAFEE, St. Louis attorney and former circuit judge, was elected president of the Union Electric Co., St. Louis, Mo., in December. Dr. William McClellan, former president, was elected Chairman of the Board and thus will remain active in the affairs of the company. Dr. McClellan went to Union Electric in 1939 from the presidency of the Potomac Electric Power Co. in Washington, D. C.

Mr. McAfee was born in Oklahoma City in 1902, graduated from the University of Missouri School of Law in 1926 and immediately settled in St. Louis. He was elected circuit judge in 1934 and resigned in 1936.

Ralph E. Moody, with a background of 25 yr. experience as an operating executive in Wisconsin utility companies, a former vice president of the North American Co. and a director of Union Electric since 1941, was elected Vice President in Charge of Operations. He was born in Milwaukee in 1890, graduated from the University of Wisconsin in 1913, and started work for the predecessor of the present Wisconsin Electric Power Co. (Milwaukee) immediately upon graduating.

New S. A. E. Officers

A. W. HERRINGTON, noted designer of military and civilian motor vehicles, was elected president of the Society of Automotive Engineers for 1942, it was announced at the Society's Annual Meeting at the Book-Cadillac Hotel in Detroit, Jan. 14. Mr. Herrington is president of the Marmon-Herrington Co., Inc., of Indianapolis, Ind. Mr. Herrington joined the SAE at the end of World War I, in which he served with distinction and rose from enlisted man to Captain of motor transport. More than half of the 20 members of the Society Council elected to serve under Mr. Herrington during this war year were in active service during World War I.



INCREASE BOILER EFFICIENCY

CLEAN TUBES Inside and Out!

1/32" SCALE CAN CAUSE 10% EVAPORATION LOSS

That's important, since today there is such an urgent need for maximum power output. Boilers are being put to severe tests. Tubes and boilers are hard to replace. One answer to these problems is Airetool Tube Cleaning equipment.

FASTER SCALE REMOVAL is made possible by the unusually powerful motor in Airetool Tube Cleaners. Airetool Motors start under heavy loads and can be loaded down to 50 RPM without stalling. Cutter head combinations can be used that will speed up any cleaning job. Tests will prove this to your satisfaction.

PARTS LAST LONGER because they are made of high grade alloy steel carefully heat treated. They are closely inspected and tested. Internal parts are ground to a slip fit so they can be reassembled without special tools.

INSIDE AND OUT, tubes can be cleaned with Airetool Tube Cleaners. Of the two cleaners illustrated above, one has a swing arm type head for cleaning inside tubes; the other has a knocker head for cracking scale off the outside of the tubes. Cutter Head shown at left is the expansion type for curved tubes. It has the Airetool self feeding feature and renewable pin plates. Brush and drill heads are also available. Heads are made for every scale condition. Airetool Tube Cleaners are made in all sizes from 1/2" I.D. to 20" I.D. for bent or straight tubes.

Complete descriptions in our free Bulletin PP-14.

CLEANERS FOR SMALL TUBES

Airetool Tube Cleaners are also made to remove light or heavy scale in straight or bent small tubes such as are found in superheaters, condensers, air coolers and air preheaters. They clean thoroughly without damaging the tubes. Heads are available for all scale or gummy conditions. These are described in Bulletin PP-14.

SEND FOR FREE BULLETIN PP-14!

Airetool Mfg. Co.
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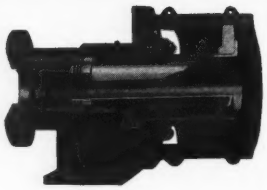
Whether you are working on defense contracts or regular production, you cannot afford costly shutdowns in your service lines.



Install ADSCO Piston-Ring Expansion Joints—the slip type joints that can be unpacked and repacked under full operating conditions without interruption to service.

Get all the facts about this modern expansion joint that's always on the job . . . write for bulletin 35-15E.

ADSCO PISTON-RING EXPANSION JOINT
for steam, hot water, oil or gas lines

Piston rings in internal guide hold line pressure during unpacking and repacking operations.

Fully guided by internal and external guide.

Available in single or double joints for high pressures and high temperatures; flanged or beveled ends.

AMERICAN DISTRICT STEAM COMPANY NORTH TONAWANDA, N. Y.

Making "UP-TO-DATE" Steam Line Equipment for Over 60 Years.

ADSCO PISTON RING JOINTS
Can Be Packed Under Pressure

Midwest Power Conference

On April 9-10 the next annual meeting of the Midwest Power Conference will be held at the Palmer House in Chicago. This conference is sponsored by the Illinois Institute of Technology with the cooperation of the nine other midwestern universities and colleges and the local sections of the Founder and other engineering societies.

Cognizant of the fact that the need in the present war effort is power, and even more power, the directorate of the Conference is doing its utmost to provide a program for this annual meeting which will not only uphold the tradition of the Conference but will also provide a stimulus in the present emergency.

Sessions will be held on: electric power transmission; industrial power plants; hydro power; fuels and combustion; Diesel power; and central station practice. The latter is sponsored by the Chicago Section of the A. S. M. E. and all arrangements for it are being made by the section's chairman of its Power and Fuels Div., J. R. Michel.

In addition to these sessions, the Conference program will include two joint luncheons, one with the Chicago Section of the A. S. M. E. and the other with the Chicago Section of the A. I. E. E. A high light of the Conference will be its All-Engineers Dinner on the evening of April 9.

The Conference will be opened by President H. T. Heald of Illinois Tech and Dr. A. A. Potter, Dean of Engineering of Purdue.

The preliminary program will be distributed toward the latter part of February and may be obtained from either Stanton E. Winston, Conference Director, or Charles A. Nash., Conference Secretary, Illinois Institute of Technology, Chicago, Ill.

New Engineering Books

In our review (p. 152, December 1941) of the Seventh Edition of The Standard Handbook for Electrical Engineers, published by the McGraw Hill Book Co., 330 West 42nd St., New York, N. Y., the price was erroneously listed as $5.00. The price of this book, actually, is $8.00.

Metallurgy and Piping—1940. Published as Bulletin No. 1-6, December, 1941, by the Edison Electric Institute, 420 Lexington Ave., New York, N. Y. Size 8½ by 11 in., 35 pp. Price: $.70 to members; $1.75 to U.S.A. non-members; $1.85 foreign.

This bulletin, edited from a report of the Metallurgical and Piping Subcommittee of the Prime Movers Committee, contains operating member and manufacturing company statements on: collecting data on creep in pipe and superheater tubing; station piping in high temperature service; large capacity reducing valves; and, high temperature bolting materials.

It is in three main sections. The first with recommendations for proper supervision of materials in high temperature service, the second a review of piping developments, the third dealing with bolting practice for high pressure-high temperature joints particularly on turbines.

1941 Supplement to A.S.T.M. Standards. Published by the American Society for Testing Materials, 260 So. Broad St., Philadelphia, Pa. Size 6 by 9 in., cloth bound; in three parts; Part I, 595 pp.; Part II, 426 pp.; Part III, 639 pp. Price $3 for any one volume; $5 for any two; $7 for all three parts. Half leather binding $1 per volume extra.

In accordance with the practice adopted 2 yr. ago the Book of Standards is published triennially, with supplements issued in the intervening two years. The above supplements, published in December, 1941, cover all changes and additions made during the past year and include in their latest forms some 370 specifications, tests or definitions.

Part I on metals includes 42 specifications on ferrous, and 82 on non-ferrous metals and alloys; and two general testing methods (chemical and spectrochemical analysis of metals). Part II includes 125 specifications and tests covering non-metallic material for construction purposes such as cement, refractories, concrete, etc. Part III covers non-metallic materials such as coal, coke, petroleum products, plastics, electrical insulation, paper, rubber, etc. Each volume also includes correction stickers for affixing to previous books indicating late changes.

It's cheaper to PREVENT scale than to remove it!

BECAUSE the Graver Hot Process Water Softener combines two distinct principles of water softening—Chemical Reaction and Thermal Action—the removal of scale forming solids is completed with exceptional rapidity. By chemical reaction the injurious elements and compounds are precipitated in such a way that they are quickly removed by sedimentation and filtration. Thermal action hastens this chemical reaction causing quicker settling of precipitate and reducing the solubility of certain chemical salts.

Thus, AFTER-REACTION is prevented and deposition of scale forming compounds in pipe lines, feed water heaters, and boilers is avoided.

Graver Hot Process Water Softeners are the result of more than 30 years of experience in the design and manufacture of water conditioning equipment of all types. Whatever your water conditioning problem may be, it will pay you to consult Graver. Send us a sample of the water you are using. We will make a thorough analysis and submit unbiased recommendations without obligation.

Send for Illustrated Bulletin

OUR bulletin, No. 303, contains complete details, charts and illustrations of Graver Hot Process Water Softeners. We shall be glad to mail you a copy on request. Write today.

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It is in such situations that DAVIS can immediately come to your assistance with what is believed to be the broadest line of automatic valve specialties in existence today. Features which you might consider "special" are often found to be standard with DAVIS, making unnecessary a long wait for special equipment to be designed and built. *For your own protection, always make it a habit to check with Davis on any automatic valve need!*

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Without obligating me, please MAIL literature describing:

- ☐ Pressure Regulators and Pump Governors (including service and capacity charts).
- ☐ Pressure Relief, Back Pressure, and Exhaust Relief Valves.
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- ☐ Solenoid Valves for Industrial service.
- ☐ Stop and Check, Non-Return and Balanced Check Valves.
- ☐ Strainers.
- ☐ A specific problem is outlined on the attached sheet. We would appreciate your recommendations.

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Index to A.S.T.M. Standards, 1941. This 173 p., 6 by 9 in. paper bound index is furnished without charge upon written request to the American Society for Testing Materials, 260 So. Broad St., Philadelphia, Pa. The index covers the Book of Standards as well as the 1940 and 1941 Supplements (see above) and lists some 1043 specifications. The index is alphabetical by key words and also in the numerical sequence of the serial designations.

Tests of Cylindrical Shells. By Wilbur M. Wilson and Emery D. Olson. Published as Bulletin 331 by the Engineering Experiment Station, University of Illinois, Urbana, Ill. Size 6 by 9 in., 129 pp., paper bound. Price $1. (A limited number of free copies available.)

This is the result of an experimental investigation of thin walled steel cylinders when used as columns. Cylinders, ranging from 4 in. seamless steel tubing to 30 in. diam. fabricated sections, were tested under axial, transverse and combined loads, and the several types of failure studied in detail.

Heat Transfer to Clouds of Falling Particles. By H. Fraser Johnstone, Robert L. Pigford and John H. Chapin. Published as Bulletin 330 by the Engineering Experiment Station, University of Illinois, Urbana, Ill. Size 6 by 9 in., 55 pp., paper bound. Price 65 ct. (A limited number of copies available for free distribution.)

While this sounds like an abstract or highly theoretical investigation, it is as a matter of fact a very practical one undertaken primarily to facilitate the design of a flash calciner for the decomposition of zinc sulphite, the product of recovery of sulphur dioxide from waste gases.

Because of the high rate of heat transfer to clouds of solid particles suspended in high temperature gases, the principle has many practical applications including: briquetting of blast furnace dust; smelting of copper and zinc ores; production of soluble phosphates; decomposition of sodium bicarbonate; and dehydration of clays, minerals, etc.

Subcontracting For Defense. This is a special report issued by the Metropolitan Life Insurance Co. and may be obtained by business executives who request it on business stationery from the company's Policyholders Service Bureau, 1 Madison Ave., New York City.

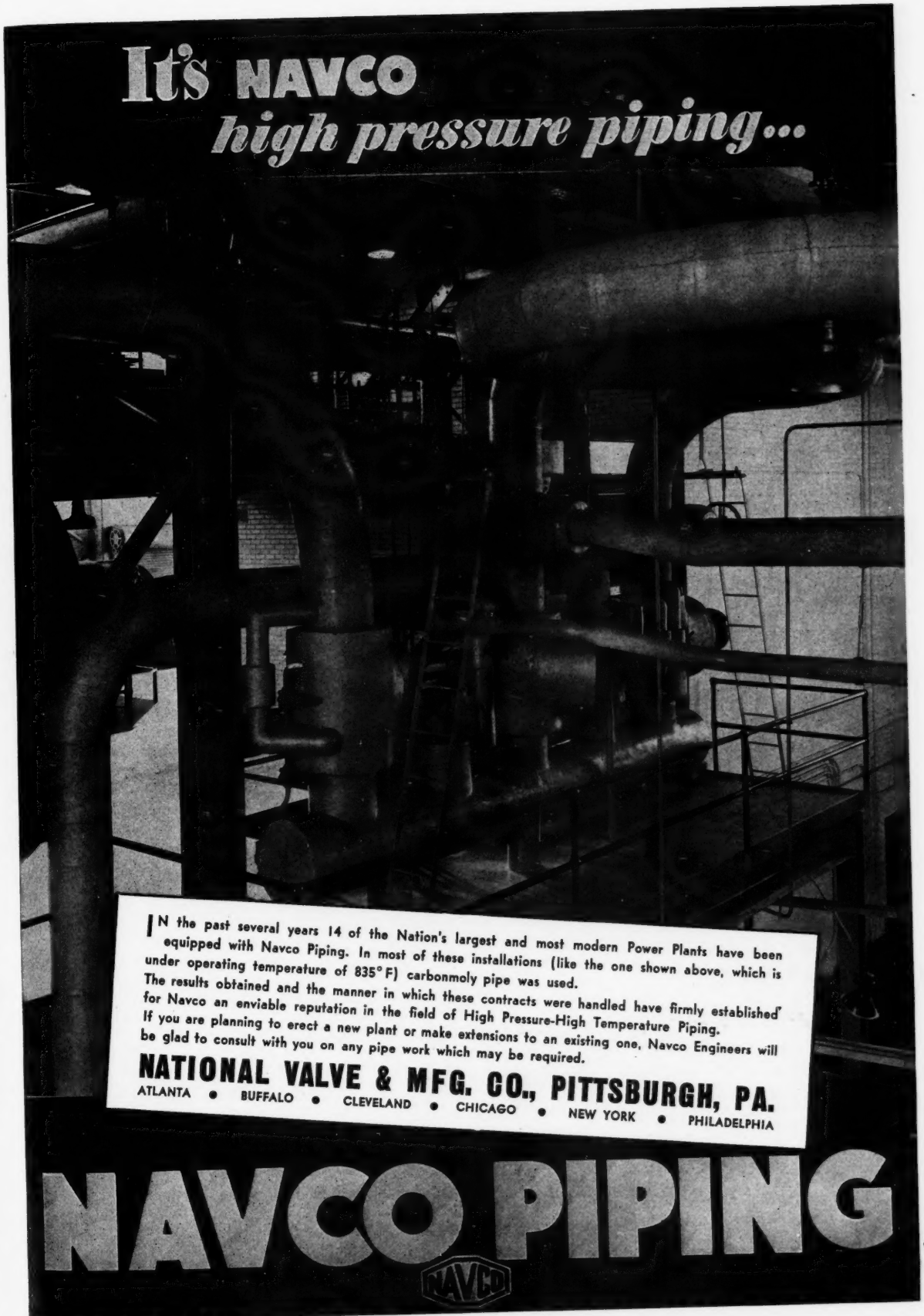
The report, a study prepared in the interest of stabilizing employment should be of interest to every manufacturer at present handling war work and more than welcome to manufacturers who want to obtain contracts. It presents an outline of the methods of meeting the problems of both primary contracting and subcontracting based on the practices of 28 companies including concerns that have been outstandingly successful in each field.

It includes sections on obtaining prime contracts for various types of supplies and equipment required by the Government; describes sources of information on governmental requirements and on procurement setup and procedure; discusses the administration of and responsibility for subcontracting in the prime contractor's organization, and steps commonly followed in selecting and scheduling work to be farmed out; shows a variety of sources which primary contractors use to locate and contact subcontractors; and methods adopted for appraising their facilities and skill.

Electrical Carbonization of Coal. This is an 8½ by 11 in., 24 p. paper bound, planographed booklet compiled by H. Stevens, 32 Ehrman Ave., Cincinnati, O., and a limited number is available for free distribution. It consists entirely of a bibliography of literature on the subject from 1900 to 1940. The potential importance of the subject is well shown by a statement of Sir Harold Hartley of England: "The carbonization of raw coal and the use of electricity in some coordinated scheme, designed to secure the maximum advantages from both, would help to solve the problem of smokeless cities, and would provide the cheap energy required in the home of the future." The address from which this is quoted, "World Heat and Power Requirements and Their Social Importance" was published in The Engineer, October 10, 1941.

Annual Municipal Conference. Report of the 18th Annual Meeting of the American Municipal Association, Headquarters No. 1313 East 16th Street, Chicago, Ill. Published as Series A. M. Report 24; 8½ by 11 in.; paper bound; mimeographed; 154 pp. Price $1.50.

The complete text of 22 addresses delivered at the association conference held in Chicago on October 23 to 25, 1941.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The results obtained and the manner in which these contracts were handled have firmly established for Navco an enviable reputation in the field of High Pressure-High Temperature Piping.
If you are planning to erect a new plant or make extensions to an existing one, Navco Engineers will be glad to consult with you on any pipe work which may be required.
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These cover all phases of municipal government activities; current problems of taxation; and municipal, state and national relationships, with particular emphasis on defense activities, civil defense programs, etc. The speaker lists included such national figures as Floyd B. Odlum and Maury Maverick of OPM, Donald M. Nelson of SBAB, Paul V. McNutt of FSA and Congressman F. C. Osmers, member of the House Committee Investigating National Defense Migration.

Thermodynamics of Boiler Feeding. By Igor J. Karassik. Published by the Hydraulic Institute, 90 West St., New York, N. Y. Size 8½ by 11 in.; paper bound; 39 pp. Price 50 cents.

This is a comprehensive treatise of boiler feeding and its place in the feed cycle of modern plants, the power and mechanical problems in relation to temperatures, and a theoretical analysis of boiler feed pump thermodynamic efficiency for both turbine and motor drive. From the practical side, the discussion of temperature rise in the pumps, the minimum suction head as affected by feedwater temperature, permissible minimum capacities and bypass arrangements and disposal is complete and detailed. Bypassing is necessary at low flows to protect the pump against dangerous temperatures. Control of this bypass and its disposal has not been standardized and the author covers the several methods in use and gives the advantages and disadvantages of each.

Electronic Level Control. Photoswitch level controls are described in Pamphlet 1100. These controls make use of a series of rugged electronic relays for level control of liquids and powders. Types are available to provide single level indication and control, on and off pump control at two levels, boiler feedwater control and tank condensate signals. Photoswitch Incorporated, Cambridge, Mass.

Metals. Fatigue of Metals is the title of a 45-pp. booklet giving facts for the designing engineer on the behavior of metals. The material is quite technical and is chiefly intended for the designing engineer in the study of the conditions which limit the stress in metals by fatigue. It contains many useful and interesting charts and graphs and has an excellent bibliography at the end. The Nitralloy Corporation.

Distribution. Plant Distribution Systems, is the title of a 77-pp. book describing everything from substations and switchgear to small auxiliary equipment used in distribution systems. It is most comprehensive and is divided into four parts as follows: 1. Radial Systems. 2. Banked Transformer Systems. 3. Plant Network Systems, and 4. Associated Electrical Apparatus. Westinghouse Electric and Mfg. Co.

Code for Measurement of Water. Published by Hydraulic Institute, 90 West Street, New York, N. Y. 1941. Price $1.00.

This code for the measurement of water using standard ISA orifices with free discharge was prepared by the Standards Committee of the Hydraulic Institute's Standards Committee of its Deep Well Turbine Pump Section, assisted by the Engineering Dept. of the University of California. It was prepared for all manufacturers of deep well turbine pumps as a guide for the measurement of capacity in the field, in testing deep well turbines when higher precision capacity measuring equipment is not available. It consists of three sections, the first outlining the application of the meter; the second giving construction specifications and the third part giving charts, tables, etc.

Neutralizing Transformers. Engineering Report No. 44. Presented by a joint subcommittee on Development and Research. Edison Electric Institute and Bell Telephone System. Edison Electric Institute, 420 Lexington Ave., New York. 1941. 16 pp., 8½ by 11 in. paper covered booklet. Price 30 cents to E.E.I. members and their employes. 75 cents to non-members in U. S. A.

This report describes two types of neutralizing transformers, one called the "power station" neutralizing transformer, developed for use on communication circuits; the other called the "toll line" neutralizing transformer, intended for reducing the effects of low frequency induction on open wire lines. Data are given whereby the effectiveness of these transformers can be determined.

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"R" MONEL.....	Cold-drawn, as drawn.....	80-115	50-100	35-15	150-230	99
"S" MONEL.....	Castings as cast.....	110-145	80-115	4-1	275-350	9-3
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**Specimen completely fractured.*

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Power Plant Construction News

Ala., Gorgas—Alabama Power Co., Birmingham, Ala., is completing plans and will take bids soon for new addition to No. 2 steam-electric generating station at Gorgas. Project will be carried out as part of 1942 expansion and improvement program, with installation to include a 60,000-kw. turbine-generator unit, high-pressure boilers, and accessory equipment. Cost reported about $4,000,000.

Ark., Camden—Arkansas-Louisiana Electric Co-operative, Inc., R. I. Davis, Natchitoches, La., president, recently organized, plans new steam-electric generating station on Ouachita River, near Camden, where site has been secured. It will have an initial capacity of about 45,000-kw., and is estimated to cost close to $4,500,000, with transmission lines and other operating facilities. Project will be carried out in cooperation with Rural Electric Administration, Washington, D. C., which will provide financing.

Ark., Malvern—Aluminum Co. of America, Inc., Gulf Building, Pittsburgh, Pa., plans steam-electric generating plant, with capacity of about 120,000-kw., at new aluminum reduction plant at Lake Catherine, near Malvern, for production for Government. Entire project will cost about $33,000,000, including aluminum mill, beauxite ore mining plant and other structures. Fund in amount noted will be furnished by Defense Plant Corporation, Washington, D. C., a Federal agency.

Conn., Waterbury—Board of Trustees, Waterbury Hospital, Robbins Street, plans new power station and mechanical-laundry at institution. Cost estimated close to $175,000, including equipment. Bids are scheduled to be asked at early date. Coolidge, Shepley, Bulfinch & Abbott, 1 Court Street, Boston, Mass., are architects; Hollis French, 210 South Street, Boston, is consulting engineer.

Fla., Dunedin—Citrus Concentrates, Inc., B. C. Skinner, president, plans installation of electric power equipment in new citrus fruit concentrating plant, comprising several one and multi-story units, designed for large capacity. Cost reported over $1,000,000. Proposed to begin work at once.

Ill., Forest Park—American Can Co., 230 Park Avenue, New York, N. Y., plans installation of electric power equipment in new plant at 7400 West Roosevelt Road, Forest Park. It will comprise a large group of buildings. Cost estimated close to $10,000,000, and fund in that amount will be furnished by Defense Plant Corporation, Washington, D. C., a Federal agency for project. Plant will be operated in name of American Corporation, a subsidiary interest.

Nev., Las Vegas—M. A. Hanna & Co., Leader Building, Cleveland, Ohio, producer of coal, iron and other ores, metals, etc., plans installation of electric power equipment in new manganese ore concentrating mill in vicinity of manganese mining properties, near Las Vegas. It will comprise several large production units with rated output of about 100,000 tons per annum. A power plant will be built. Entire project will cost about $4,500,000 and fund in that amount will be furnished by Defense Plant Corporation, Washington, D. C., a Federal agency, with Metals Reserve Co., Washington, another Government agency, to acquire complete mill production. Project will be carried out in name of Manganese Ore Co., a subsidiary of Hanna Co.

Md., Crisfield—Town Council has plans under way for new municipal power plant. Cost estimated about $500,000, with turbine-generator, boilers and accessory equipment. Application has been made to State Public Service Commission for permission to arrange bond issue in amount noted. Perring & Remington, 10 West Chase Street, Baltimore, Md., are consulting engineers.

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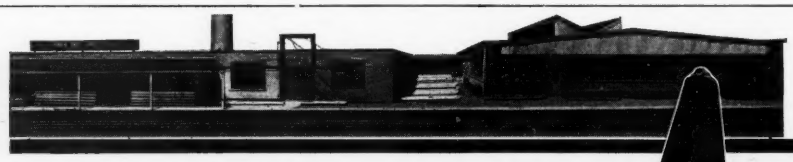

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AGENTS IN PRINCIPAL CITIES

Mass., West Roxbury — Construction Service, Veterans' Administration, Washington, D. C., will receive bids until Feb. 24 for boiler house and main hospital building, with auxiliary structures, at West Roxbury, including boilers and boiler plant equipment, radial brick stack, etc.; also for refrigerating plant and equipment, and air-conditioning plant and equipment (Project 1969).

Mich., Detroit—Detroit Edison Co., 2000 Second Avenue, has plans under way for new steam-electric generating station at foot of Orleans Street, fronting on Detroit River, to be equipped for initial capacity of 75,000-kw. Turbine-generator of rating noted will be furnished by General Electric Co., Schenectady, N. Y., with contracts for other equipment to be awarded soon. Proposed to begin work late next fall. Cost is reported over $4,000,000, with transmission line extensions.

Minn., Benson—Western Minnesota Electric Co-operative Association, Benson, plans series of three or more steam-electric generating plants for power supply for rural electric systems in several counties of State. An initial fund of about $1,500,000 has been secured through Federal aid for project. General Engineering Corporation, 2944 Cedar Avenue, Minneapolis, Minn., is consulting engineer.

Minn., Rochester—Rochester Dairy Co., Rochester, plans installation of electric power equipment in proposed two and three-story milk dehydrating plant on local site. A boiler house will be built. Entire project will cost about $100,000. Max O. Buetow, 1931 University Avenue, St. Paul, Minn., is architect.

N. J., Perth Amboy—Harris Structural Steel Co., New Market, N. J., plans installation of electric power equipment in new shipyard in Maurer district, Perth Amboy, where tract of about 42 acres of waterfront property has been acquired. New plant will be used for production of vessels for Government. Work will begin soon. Cost reported about $200,000.

N. M., Albuquerque—Board of Regents, University of New Mexico, plans call for bids in near future for pumping machinery, pressure storage tank and auxiliary equipment for increased water supply at institution. Cost about $40,000.

N. Y., New York—Department of Hospitals, 125 Worth Street, has preliminary plans under consideration for extensions and improvements in power house at Fordham Hospital, Bronx, with additional equipment installation for increased capacity. Cost reported in excess of $400,000.

N. Y., Tonawanda — Exolon Co., Blasdell, N. Y., manufacturer of abrasive products, magnetic separators, etc., plans installation of electric power equipment in new plant at Tonawanda, where tract of about 35 acres of land has been acquired on East Niagara Street, with frontage on Barge Canal. Main unit will be about 300x400 ft. Entire project will cost close to $500,000. William A. Harty is president.

N. C., Southport — Electric Light Department has plans maturing for extensions and improvements in municipal power plant, with installation of equipment for increased output. Cost estimated about $91,100.

N. C., Tarboro — City Council is considering extensions and improvements in municipal power plant, including installation of additional equipment for increased capacity. Cost reported about $210,000. It is proposed to arrange bond issue in that amount.

Ohio, Cleveland — Harris Division of Harris-Seybold-Potter Co., 4510 East Seventy-first Street, manufacturer of offset and gravure presses, parts, etc., plans installation of electric power equipment in new one-story addition, about 35x325 ft. Cost reported close to $175,000. Proposed to begin work soon. Walter H. Smith, 2400 Lee Road, is architect.

Pa., Philadelphia—SKF Industries, Inc., Front Street and Erie Avenue, manufacturer of ball bearings, etc., plans installation of electric power equipment in new one-story addition, about 145x295 ft. Cost over $200,000.

Texas, Borger—Panhandle Power & Light Co., Main Street, has work under way on expansion in local steam-electric generating station, for additional capacity in steam division. Installation will include new boiler unit, with rating of 150,000 lb. of steam per hour, and auxiliary equipment. Contract for boiler has been let to Combustion Engineering Co., New York, N.Y., and awards for other required equipment will be made at once.

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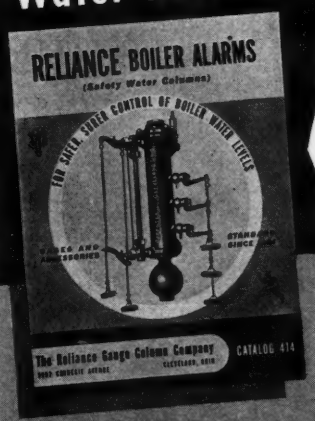

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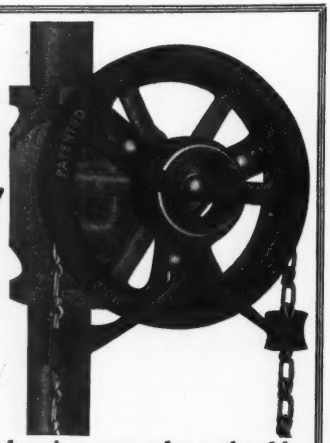

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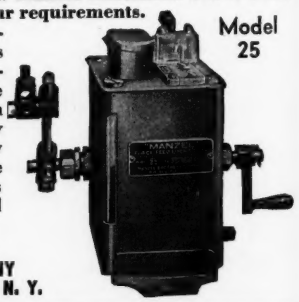

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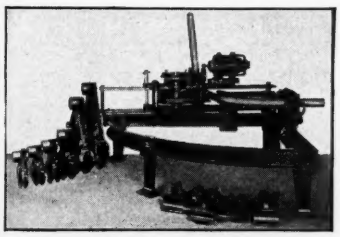

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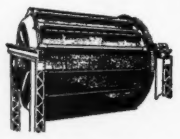

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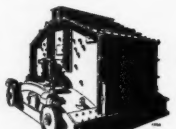

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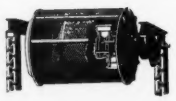

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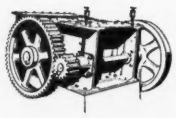

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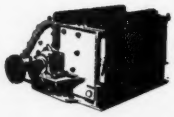

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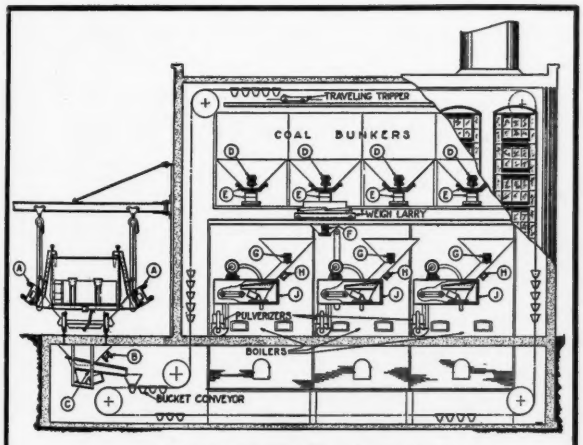

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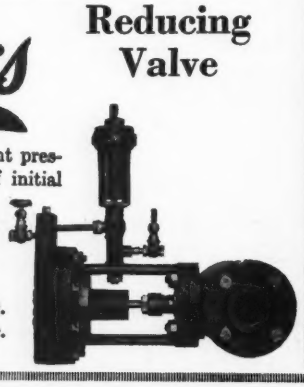

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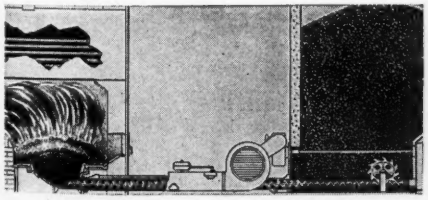
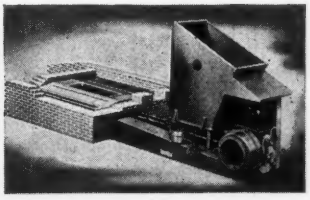


BUNKER FEED. This is the type of Iron Fireman stoker adopted by Vultee. Built-in coal conveyor feeds coal direct from bin to the fire.



POWERAM. The heavy-duty power stoker. Combines worm feed with ram distribution of coal in retort.

Iron Fireman Can Do These Things for You

In hundreds of war-production plants, Iron Fireman firing is helping increase steam capacity—and boost production. In many cases, the adoption of Iron Fireman firing has eliminated the need for enlarged boiler capacity. For 18 years, Iron Fireman stokers have been setting low fuel-cost records in nearly all major industries.

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Automatic Coal Stokers

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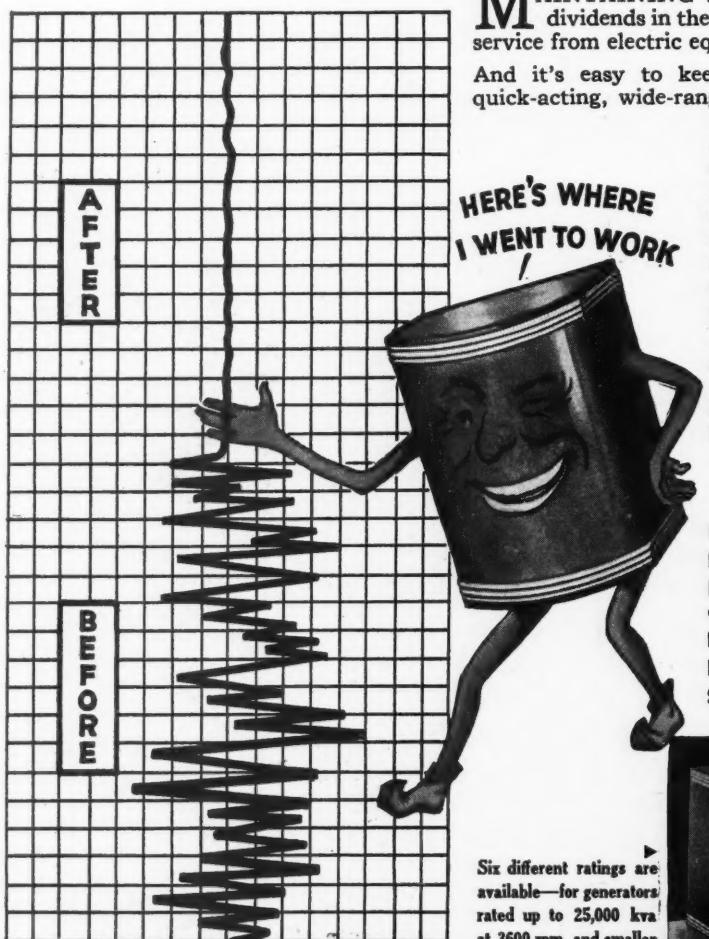

A typical voltage chart before and after the application of a G-E Diactor regulator

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Direct action—for fast operation
Electrical damping—no dashpots
Reliability and long life—no vibrating contacts
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Normally stationary parts
Simple construction—only six leads required

Six different ratings are available—for generators rated up to 25,000 kva at 3600 rpm, and smaller machines at correspondingly lower speeds

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TO A DROP-TIGHT SEAT..

to prevent head-loss and line-damage

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CHICAGO, FEBRUARY, 1942

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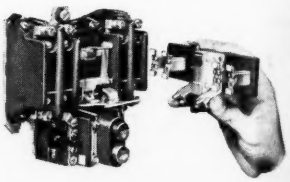

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